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Selecting Highway Surfacing Types

Basis of decision upon low, intermediate or high type of surfacing. Kinds available under each classification. Standard mixing and constructing details of each

By A. G. Bruce*

In the planning of any highway improvement, whether city, county, or state work, one of the most important considerations is the selection of the type of surfacing. Before deciding this question, some preliminary study should be made to determine—

1st. The nature of the soil on which the road is to be built.

2nd. The kind, volume and weight of the traffic which will use the road during the next ten or fifteen years.

3rd. The availability, cost, and relative durability of materials adequate for the class of pavement dictated by the conclusions for points *one* and *two* above.

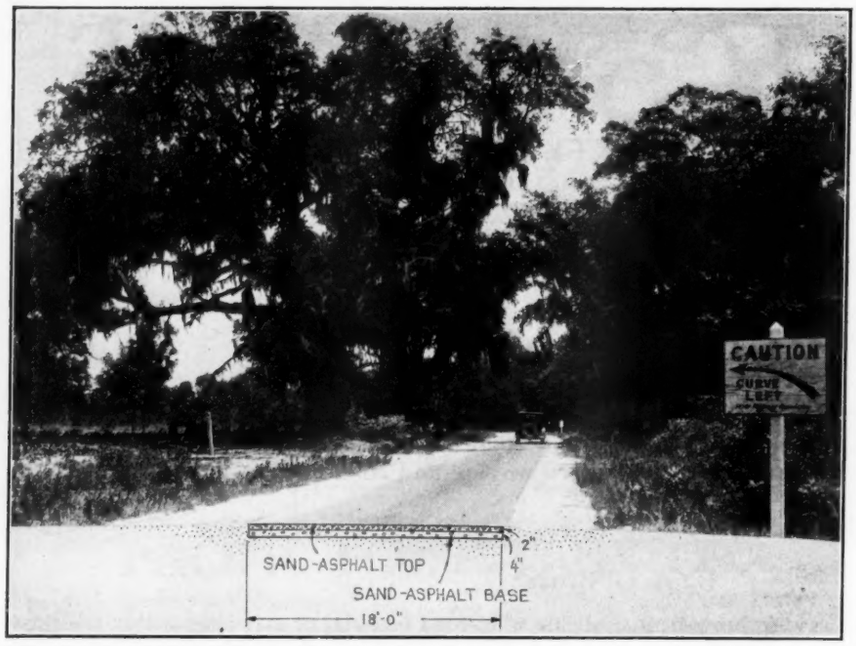
A careful determination of the first two points will indicate what class of pavement is needed—that is, whether a low type, an intermediate type, or a high type; and a determination of the third point will indicate what road material or materials within the class should be most economical as well as most adequate for the expected traffic.

The regional studies made by planning commissions during the past few years have demonstrated the benefits that may result from intelligent investigation under competent supervision, and no large undertaking should be started without such preliminary study. It will be necessary, however, for many individual road jobs to be started without such a general survey, and in such cases the engineers and officials in charge should themselves make sufficient local studies to permit the selection of a proper location, and an intelligent choice of the type and design of the road surfacing adequate for the expected traffic.

There is no clear line of demarcation between the various classes of surfacing, but the majority of highway engineers arrange the usual types under the following classifications:

TREES WITH HISTORIC INTEREST SHOULD BE PRESERVED AND MARKED.
Under this tree in North Carolina George Washington rested in 1791.

*Senior highway engineer, U. S. Bureau of Public Works.



SAND-ASPHALT IN NORTH CAROLINA

The base types that may be used with these surfacing types are also numerous and the possible combinations of materials for base and top are almost limitless.

LOW TYPE SURFACINGS

The low type group of surfacings has quite generally been selected for normal traffic up to 500 vehicles per day, except where trucks or busses constituted more than 10% of the whole number, or if unusually heavy loads of any kind predominated. Recent research, however, shows that even where normal traffic conditions prevail, the operating cost per vehicle-mile, according to Professor Agg, may be from ¾ to 1 per cent more than where some intermediate type is used and thus with a traffic of only 300 vehicles per day, the road

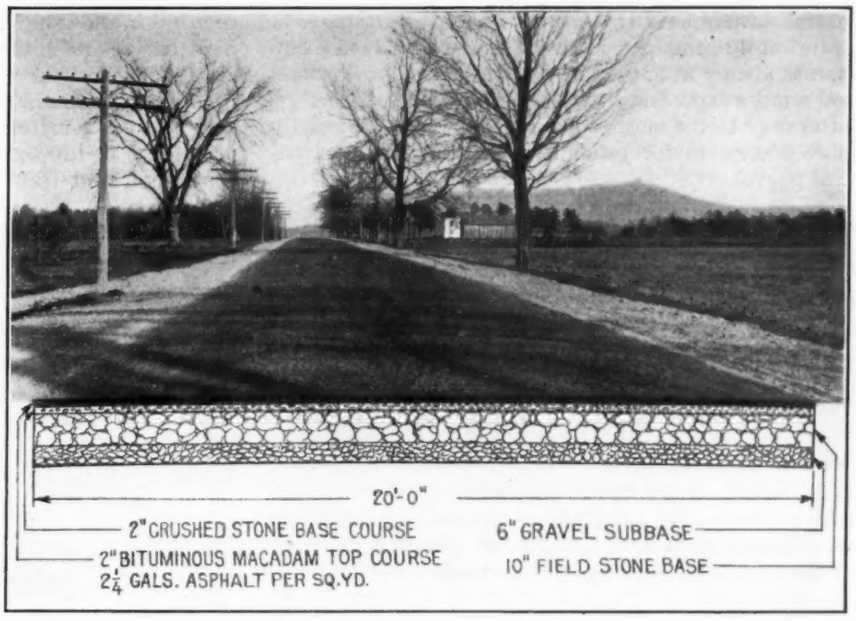
CLASSIFICATION OF TYPES OF SURFACING

Low Type	*Intermediate Type*	*High Type*	*Low Type*	*Intermediate Type*	*High Type*
Top Soils	Waterbound macadam (surface treated)	Bituminous concretes (hot mixed)	Gravel	Bit. macadam (penetration)	Portland cement concrete
Sand-Clay	Sand Asphalt	Bituminous concretes (cold laid)	Chats and chert	Sand (oil processed)	Brick and other block types
Disintegrated granite	Gravel (surface treated)	Natural rock asphalt	Cinders and slag	Gravel or stone (oil processed)	
			Caliche and soft lime rock		
			Shell		

GRAVEL ROAD

users are paying approximately $1000 more per mile per year than for an intermediate type of surfacing. Many low-type surfacings may be kept in a fairly smooth condition by constant dragging, but the dust nuisance in dry weather is a serious menace to the safety of the road user and a source of annoyance to the housewife who lives near the road. Another factor not to be overlooked is the high cost of maintenance on the low-type road surfaces. Studies made in several states during the past few years indicate that yearly maintenance expense may run as high as $1200 per mile for normal traffic of 500 vehicles per day.

Taking all these elements into account, there appears to be little justification for the low-type surfacings other than as the first stage of some higher type of improvement, except on distinctly pioneer roads where the traffic is so light as to preclude the consideration of anything better.

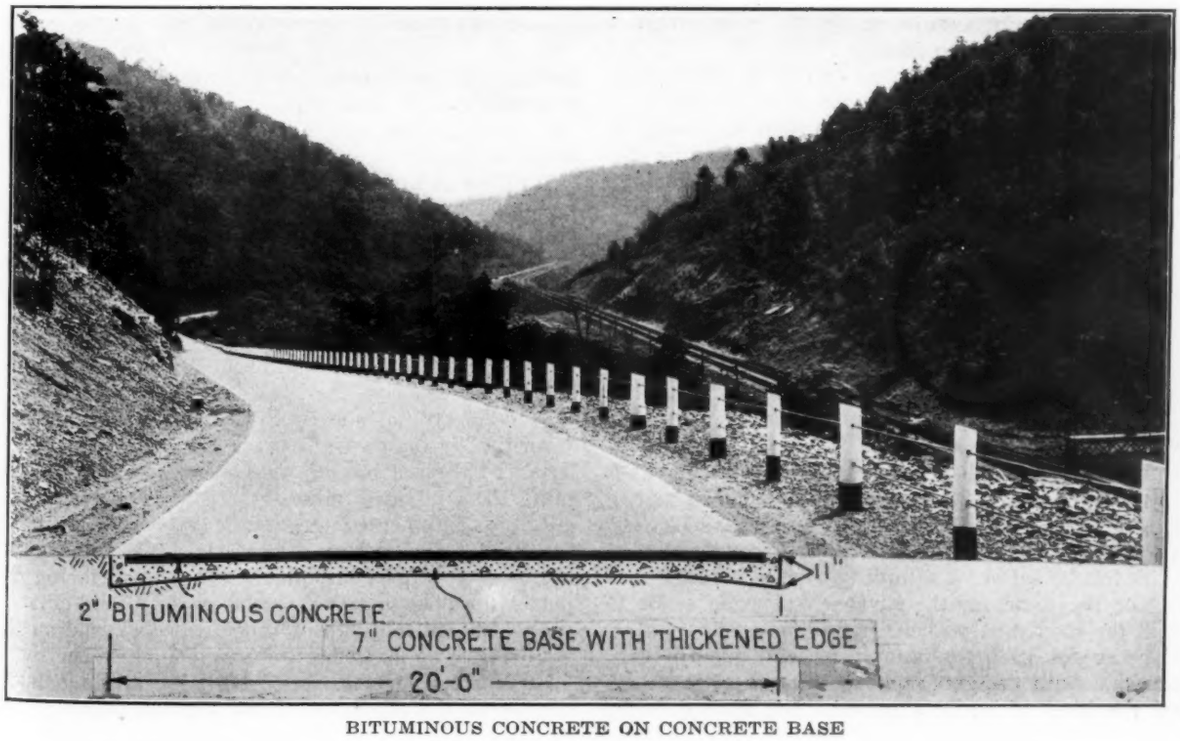


HEAVY-DUTY BITUMINOUS MACADAM AS CONSTRUCTED BY THE MASSACHUSETTS STATE HIGHWAY DEPARTMENT

Considerable research and experiment has been conducted during the past two or three years in an attempt to develop surface treatments for the low-type road materials which would make them adequate for moderate traffic without excessive maintenance costs. The excellent compilation of data on low-type materials and their surface treatment by C. N. Conner of the Highway Research Board is so well known that no further reference to these details will be attempted in this article, but any engineer contemplating the construction of low-type roads should not fail to study the Conner report.*

Assuming that some kind of bituminous treatment is contemplated, consideration should be given to the selection of some material that is favorable for such work. A material which might be satisfactory if left untreated may contain too high a clay content for suc-

*See also "Surfaces Suitable for Secondary Roads" by Mr. Conner in *Public Works* for May 1928.



BITUMINOUS CONCRETE ON CONCRETE BASE

cessful bituminous treatment, and in such cases a gravel at 40 cents per cubic yard may be a better buy than sand-clay at 25 cents. Also, if both natural gravel and a more expensive crushed gravel are available, the latter may be the most economical because it is usually more successful for bituminous treatments than natural gravel.

INTERMEDIATE TYPE SURFACINGS

The intermediate-type surfacings are generally adequate for normal traffic up to 1500 vehicles a day, although some heavy bituminous macadam roads, such as are built in Massachusetts and Rhode Island, are taking several thousand vehicles per day without appreciable ill results. Waterbound macadam with a bituminous treatment is being constructed in a few states, but the cost is nearly as much as for bituminous penetration macadam and the maintenance is considerably higher. Sand-asphalt is used to good advantage where the natural subgrade is composed of material which lends itself to this treatment. The best examples of this type of surfacing are the roads constructed by Massachusetts on Cape Cod, those constructed by North Carolina on the sandy soil near Wilmington, and those constructed by Delaware in Sussex county.

During the past few years the bituminous treatment of gravel roads has been the subject of extended research and experiment and many new methods have been developed which appear to be highly successful. The oil-processing method so widely used in the west is expected to save large sums in maintenance costs besides adding greatly to the delights of touring. The grade of light oil used in the Western processing method is not yet commercially available in the East, where the single and double surface treatment of heavier oils is the common practice; but attempts are being made in several Eastern states to develop a processing method similar to the Western practice but using cut-back asphalt instead of fuel oil.

The bituminous macadam penetration surfacing is the oldest and best known and generally speaking the most successful of the intermediate types of surfacing. In New York and most New England states where field stones are abundant, this material is generally used to good advantage for the base course; while in Ohio, where commercial crushed limestone and crushed slag are readily obtained, the water-bound macadam type of base is prevailing practice. Other materials commonly used for base courses are gravel, shell, caliche, soft sandstone, limestone, and coral rock.

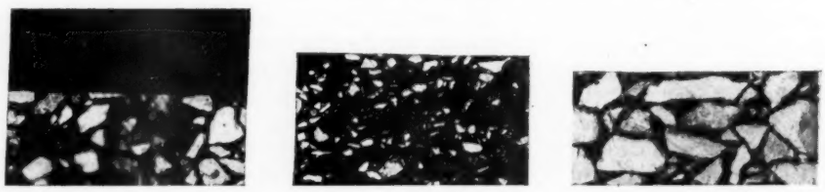
For the surface course, a stone having a French coefficient of 6 or 7 is usually specified, although in some cases stone with a French coefficient as low as 5 has been used successfully. The maximum size stone for this work depends in some degree on its hardness, and varies from 2 inches for the hard varieties to 4 inches for the softer. Uniformity of size is very essential for the stone for the surface course, in order to avoid the chance of pockets of fine material.

The specification for bituminous material will vary somewhat with the geographical location of the work and the kind of traffic expected. For normal traffic conditions, the standard penetration for asphalt should be from 80 to 100 for high temperature localities, and 120 to 150 for northern conditions. Where tar is used as the bituminous cement, the specifications usually require a material having a float test, at 50°C. (122°F.), of 120 seconds to 180 seconds for northern conditions, and 160 seconds to 220 seconds for southern states.

The relative merits of tar and asphalt for binder course as well as for surface treatments are the basis of some controversy among engineers. Under some conditions asphalt has distinct advantages but under other conditions the tar is preferable. Both materials have been used for many years with success and it is probable that the manner of manipulation and the skill of the operators have more to do with the results than any intrinsic quality of the tar or asphalt. The material should be applied with pressure distributors at a temperature of about 300°F. for asphalt and 200°F. for tar. The usual pressure for such distributors is 25 pounds per square inch, and applications should not be made when the air temperature is below 50°F.

HIGH TYPE SURFACINGS

The road surfaces usually referred to as high type are the bituminous concretes, the natural rock asphalts, portland cement concrete, and brick. The bituminous concretes are usually divided into three main groups, namely, fine graded (such as sheet asphalt), medium graded (such as Topeka), and course graded asphaltic concrete. All of these types require that the various sizes of aggregate be graded so as to produce a minimum of voids.



FINE GRADED ON BINDER COURSE — MEDIUM GRADED — COARSE GRADED

THE THREE GENERAL CLASSES OF BITUMINOUS CONCRETE

As there is little beam strength in this type of surfacing, it must be laid on an adequate base of some kind. The two types of bases used for this purpose are the rigid and the non-rigid. The rigid type base is usually of portland cement concrete, although old brick or stone block pavements may be used for this purpose. The non-rigid bases are of waterbound macadam, gravel, caliche, shell, marl, slag, and soft limestone.

Another type of non-rigid base which has come into favor during the past few years is the so-called "black base." This is a bituminous concrete mixture resembling the top course mixtures but with larger aggregate, less bitumen content, and less control generally of grading and quality of material. The selection of the base type for a bituminous concrete surfacing depends in a large measure on the local soil and climatic conditions, on the kind of traffic expected, and on the availability of materials for base courses. The durability of the surface course will depend in a large degree on the adequacy of the support furnished by

the base course, and any attempt to cheapen the cost of the improvement by providing too light a base course is false economy and is almost sure to result in failure.

Under average conditions, an 8-inch compacted thickness is the minimum for the non-rigid type of base and 6 inches the minimum for the portland cement concrete base. For black base it is usual to require at least 4 inches thickness, and this is usually placed on a sub-base of gravel or sand-clay. It is very essential that the non-rigid base be thoroughly compacted before the top course is laid and best results are obtained where the base is laid and compacted by traffic several months prior to the placing of the top course. During the past few years the thickened-edge design for concrete bases has become popular and the justification for this design is the same as for the thickened-edge pavement.

Up to recent years the sheet asphalt pavement was considered a city type and too costly for rural road improvement, but improved methods of plant manipulation have resulted in bringing the cost down to a point where it compares favorably with the other bituminous mixes. The sheet asphalt type of bituminous concrete is usually laid in two courses, the bottom layer being commonly referred to as the binder course. This binder course is usually 1½ inches in compacted depth, but sometimes a 1-inch course is used. The material for this binder course is clean, durable crushed rock, sand and asphaltic cement, combined in such proportions as to produce a mixture within the following limits—

Passing a 1-in. circular mesh and retained on a ½-in. mesh	35–65%
Passing a½-in. circular mesh and retained on a 10 mesh	10–35%
Passing a 10 mesh sieve	25–35%
Asphaltic cement	4–6%

The sheet asphalt surface course is usually built 1½ inches compacted thickness, although some pavements have been built with a 1-inch course. The materials for the surface course are sand, mineral filler and asphaltic cement combined in the following proportions—

Passing a 10 mesh, retained on a 40 mesh	10–40%
Passing a 40 mesh, retained on an 80 mesh	22–45%
Passing an 80 mesh, retained on a 200 mesh	12–30%
Passing a 200 mesh	10–20%
Asphaltic cement	9.5–12%

The asphaltic cement for this course should have a penetration of from 40 to 50 for southern climates and from 50 to 60 for northern climates.

BITUMINOUS CONCRETE—TOPEKA TYPE

This consists of a mixture of crushed stone, sand, mineral filler and asphaltic cement combined so as to produce a mixture conforming to the following proportions—

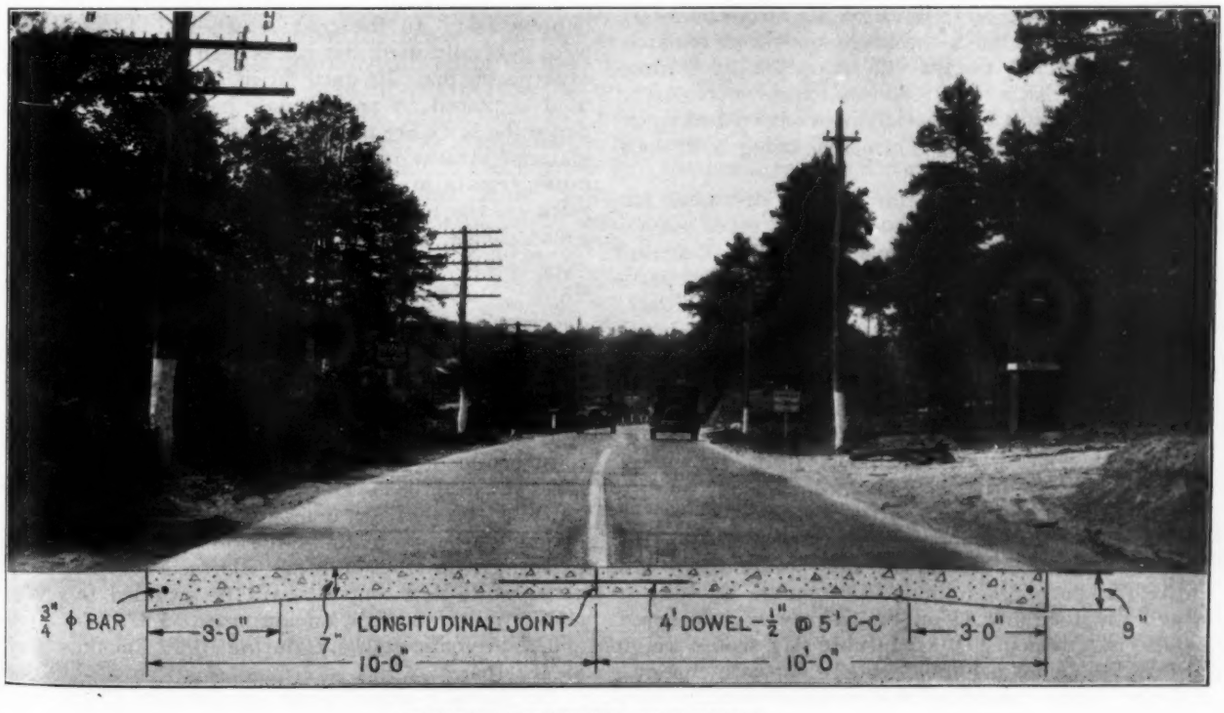
Passing a ⅝-in. screen, retained on a ¼-in.	12–25%
Passing a ¼-in. screen, retained on a 10 mesh	10–20%
Passing a 10 mesh, retained on a 40 mesh	7–25%
Passing a 40 mesh, retained on an 80 mesh	11–36%
Passing an 80 mesh, retained on a 200 mesh	10–25%
Passing a 200 mesh	7–11%
Total bitumen	7.5–9.5%

The penetration of the bituminous material used for Topeka is usually 60 to 70 for northern climates and 50 to 60 for southern climates. Unlike sheet asphalt, the Topeka mix is laid directly on the base in one course 1½ inches to 2 inches compacted thickness.

BITUMINOUS CONCRETE—COARSE GRADED TYPE

This is composed of crushed stone or gravel, sand, mineral filler and asphaltic cement combined in approximately the following proportions—

Passing 1¼-in. screen, retained on ½-in. screen	30–60%
Passing ½-in. screen, retained on ¼-in. screen	15–25%
Passing ¼-in. screen, retained on 10 mesh screen	5–15%



CEMENT CONCRETE PAVEMENT

Passing 10 mesh screen, retained on 200 mesh screen	20–35%
Passing 200 mesh screen	4–6%
Total bitumen	5–8%

It is customary to put a seal coat on this type of bituminous concrete, either of asphalt and stone chips, or of pre-mixed sand and asphalt, or of natural rock asphalt. The penetration of the asphaltic cement varies with the climatic conditions but generally is from 60 to 80 in northern states and 40 to 60 in southern. The course is usually 2 inches thick, laid on a base course of either the rigid or the non-rigid type.

NATURAL ROCK ASPHALT

The two classes of natural rock asphalt found in the United States are limestone rock asphalt and sandstone rock asphalt. The best known deposits of the limestone variety are found in Texas and the best known deposits of the sandstone in Kentucky. Deposits also occur in Oklahoma, Alabama, California and Utah, but not all are suitable for road work without the admixture of other materials.

The rock asphalts as mined contain a varying percentage of asphalt, that near the top being leaner than that lower down, and it is necessary, therefore, that the quarried product be proportioned at the crusher, so that the crushed output will have a uniform and proper asphalt content. The material is usually crushed at the mines to about ½-inch size down to meal, and shipped to the job cold. Here it is fluxed and remixed if necessary, and usually laid cold on a prepared base of either the rigid or non-rigid type. The Texas rock asphalt, commonly called "Uvalde," is laid both hot and cold, but during the past two or three years the latter appears to have been the more popular. The depth of the rock asphalt wearing course is usually 1½ inches or 2 inches, although 1-inch compacted thickness is not uncommon.

PORTLAND CEMENT CONCRETE

This type of pavement has become very popular for rural highways and large mileages are built each year. Because of its general use, a large amount of research has been directed towards its improvement during recent years. As a result of this extensive research, much better control of materials is practiced and much stronger and smoother pavements are being built than those of a few years ago.

The materials used for this type of pavement are water, portland cement, sand, and crushed stone, gravel or slag, mixed in various proportions but usually about in the ratio of one part cement, two parts sand, and three or four parts of the coarse aggregate. Until recently the proportions were measured by volume, but on account of the bulking of damp sand and the resulting inaccurate proportioning of aggregate, the volumetric proportioning is giving way to weight proportioning.

Crushed stone, gravel and blast furnace slag are used as coarse aggregate. Requirements for quality vary somewhat in different sections of the country. In general, however, any good, sound crushed stone or gravel of reasonable hardness, if properly sized, will prove satisfactory. A limited percentage of wear of 6 or 7 on stone and 15 on gravel may be considered typical requirements. Blast furnace slag should weigh at least 70 pounds per cubic foot. In northern climates, however, where chains are used on motor vehicles, very soft aggregate should not be used. The sand or fine aggregate should be selected with care because the strength of the mortar content will depend in a large measure on the quality of the sand. Sand with organic impurities, or which contains more than 3% of foreign matter such as clay or silt, should not be used.

The thickness of the concrete pavement will depend on the loads it is to carry and the support offered by the subgrade, but most pavements are now built with thickened edges and the thickness determined according to Older's formula: D (the edge thickness)$= \sqrt{\frac{3W}{S}}$, where W=the wheel load in pounds, and S= the maximum allowable fibre stress in pounds per square inch. The center thickness is made .7 the edge thickness. The maximum wheel loads usually permitted by law range in the various states from about 8,000 to about 11,000 pounds. To allow a margin of safety, for taking care of factors which affect the stress but whose influence cannot be accurately estimated, it is customary to use a working stress (S) which is one-half of the ultimate bending strength or modulus of rupture of the concrete. For modern paving concrete this working stress will generally be about 300 pounds per square inch. The thickness of pavement thus determined will be 10–7–10, 9–7–9, 9–6–9, or 8–6–8 depending on the values of W and S and on the approximations permitted.

The use of steel reinforcement in concrete pavements is quite general but the amount and disposition of it varies greatly in different states. The majority of states use edge bars only, but some states use bars or mesh throughout the slab.

BRICK PAVEMENTS

Brick pavements are usually laid on a rigid-type base of 6 inches to 8 inches depth, but many successful pavements of brick have been laid on non-rigid bases. The failures of brick pavements, to the same extent as for bituminous concrete, have usually been caused by base failures, and it is false economy to cheapen the base in an attempt to lower the cost of the improvement. In the past 3-inch and 4-inch brick were generally used, but it has been found by careful experiment that 2½-inch brick can be successfully used if placed on an adequate base. The joints between the brick are now usually filled with bituminous material because less cracking is experienced and because repairs are more readily made and the brick more readily salvaged, than is possible with cement grout filler.

Road Expenditures in Chile

The largest road construction program ever undertaken by the Chilean Government was initiated in 1928, according to a report from Commercial Attache Ralph H. Ackerman. Contracts amounting to 49,650,000 pesos ($6,013,095) were awarded for the construction or improvement of 974 kilometers (605 miles) of new roads. Of these contracts, work amounting to $1,433,124 was done during the year. It is expected that work to the value of $2,696,122 will be performed in 1929 on the contracts awarded last year; while new contracts will be awarded this year on 374 miles of roads amounting to $5,373,126. It is hoped to complete work during 1929 amounting to $4,487,164.

Of the 605 miles being constructed, 171.5 miles are natural earth, 187.9 miles are of gravel, 91.3

miles of refuse from nitrate workings, 54.1 miles of gravel and crushed stone, 17.8 miles of surface treated gravel, 6.2 miles of bituminous macadam, 20.6 miles of cement concrete, 50.5 miles of reinforced concrete, and 5.4 of Warrenite-bitulithic. Of the contracts to be awarded this year, nearly half will be gravel, next in length will be broken stone, followed by bituminous macadam, concrete, and finally 15 miles of natural earth.

A law recently passed authorizes the issuance of nearly $11,000,000 to be used for roads. The program of road construction will be decided by the executive. The roads in general are divided into five categories: 1. Roads giving access to consuming centers or between different consuming centers; 2. Roads giving access to railway centers; 3. Roads to ports; 4. A longitudinal highway; 5. Other highways.

Contracts may be awarded only after competitive bids have been presented; but where such bids have been called for at least twice and no offers received, the work may be undertaken by the administration. Administrative contracts may be let without competition in case of emergency where the work will not cost more than $24,000.

Collection of Basic Data and Their Use in Road System Design

Study of the people and traffic which will use the roads, value of the proposed roads to the community, and financial ability of taxpayers to pay for them

By Theron M. Ripley*

"Basic Data" takes us back to the beginning of whatever is under consideration, and "Road System Design" is the beginning of a system or plan upon which the roads are to be constructed. We must, therefore, start back with the people who use the roads, and those who (in our judgment) will use them; to the kind of traffic which does and will use them; and to the financial ability of the people to pay, now or in the future, for the work necessary; and this ability must be determined upon the basis of the value of the proposed system to the community.

As the bulk of traffic, in both kind and volume, is adjacent to centers of population, there is usually little or no question about the necessity of highway improvements and a coordinated system in these localities. Such a system naturally starts from the corporate limits of a city or other urban unit, and follows the lines of existing roads. The main question in designing the system at this point is the number of roads to be provided and which shall be the favored ones. It is in the arguments engendered in the selection of local routes that the most acrimonious feeling may be developed and the local politician is most apt to be a disturbing factor.

In determining upon the number of routes, the width of pavement has come to be a factor, as the main routes adjacent to all our cities have been or are rapidly becoming routes upon which a pavement that is only wide enough for one lane of traffic moving in each direction is too narrow.

The design of the "system" must not be confused with the design of its component parts, viz; type, width and thickness of pavement, bridges, etc.; but the general features of these must be considered, as no system can be built upon a location having prohibitive bridge costs, prohibitive grades, etc.

The system design deals primarily with the following questions:

(a) What does the present and probable future traffic require?
(b) Can the community—be it city, county, state or federal—pay for the cost and maintenance?

In determining what the traffic requires, it must always be borne in mind that the highway cost must be justified by the traffic, just as in the case of any other transportation agency.

Although the greatest traffic is adjacent to cities, some of this traffic must proceed through rural communities to serve not only those communities, but also the neighboring cities; therefore, the connecting routes must be so laid out that this interurban traffic can be served economically.

The remark has been made by some highway men that grades do not mean anything to gasoline; but to watch a two-ton, or heavier, truck operating upon a comparatively level road at the rate of from 15 to 30 miles per hour; then, to see the same vehicle laboriously climbing a hill at a rate of from four to eight miles per hour with the throttle wide open, tends to convince me that gasoline-developed power is not entirely unaffected by rates of grade. In considering this question, we must ever bear in mind that the vehicles using our main highways are numbered by the thousands per twenty-four hours and an unnecessary cost of operation of only a few cents per vehicle per day rapidly becomes an unwarranted loss to the community.

In designing the system, not only the normal future growth of population and industries is to be considered, but also the change in traffic conditions, and no one can adequately design such a system unless he is a "bull" not only on his own community, but on the neighboring communities as well. In other words; no one who is willing to assume that the greatest gain is made by selling his country "short" can adequately design a highway system for it.

An interesting example of this kind came to the

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writer's attention several years ago in laying out a route of a system. This route was projected up a narrow valley which contained a main trunk line railroad. In order to avoid two crossings of this railroad it was directed that the survey be carried at one point along the mountainside, which, because of a cliff, brought the road to a point about 300 feet above the valley. Fortunately, this road has not been built. If it had been built upon the line as surveyed, this 300-foot climb would have been the only hill of similar magnitude in a distance of 200 miles, along which were scattered seven cities ranging from ten to one hundred thousand population and numerous villages. Such a design would have been bad, for long before bonds were retired the loss to the travelling public would have been much greater than the difference between the cost of the hill line and that of the valley line including the bridges to carry the road over the railroad and the adjacent creek.

In the rush to provide pavements upon which the rapidly increasing number of motor vehicles can be operated, there is a possibility of losing sight of the range of economic possibilities. A route once established and the pavement built thereon is difficult to change, and so far as possible the route must be considered with the time limit at least as long as that for which the first bonds are issued for its payment.

Taking up now the question of the ability of the community to pay: The question, "Is it a good thing to do for the community?" must be settled first; and in determining this question, not only the actual money cost must be considered, but also all those indeterminate things which go to make a community a better place to live in.

As all highway systems are public property and under the control of the government, public officials must be looked to for the money with which to make the improvements, and these officials must be "sold" upon the plan for any system before the finances for making it a reality can be secured. There are few, if any, communities in the United States today that are so poor that they cannot build the proper system of highways required. Yet, some think they are; and others have squandered their resources and feel the pinch of poverty so severely that, after acknowledging the necessity for a highway improvement, the officials dare not advocate to their constituents the expenditure required. In communities where this is the case, the work must be delayed indefinitely or else the public must be "sold" to such an extent that the officer who desires re-election will realize that he is not committing political suicide by advocating an increase in the tax rate in order to provide the improvement.

When this condition exists, it is well for the designer to ascertain whether it is an excessive tax rate or uneconomical expenditures with which the community is overburdened. It may be found that the largest tax payers, and many who are volubly objecting to the tax rate are, in fact, objecting to the small return received for the taxes paid.

Having determined what should be the general layout of the system, it should then be checked against the possible traffic volume to determine whether it is too ambitious or should be enlarged. In making such a determination, some unit of volume which can safely and speedily use the highway must be determined. This unit is believed to be that amount of traffic which can safely and speedily pass over a two-way road (that is, a road having one lane of traffic passing in each direction) in twenty-four hours. I have tried for a number of years to gather data upon this subject, but, like many other problems in the highway field it seems, at the present time at least, to be purely a matter of opinion rather than one of mathematics. One state official who for a number of years has had charge of maintenance and traffic in a New England state told me that he considered 6,000 vehicles a day as the number which could use a two-way pavement with safety and speed. At that time I was using as my figure 9,000 per day. Since that time I have had one engineer give me an estimate as high as fourteen or fifteen thousand per day. As an opinion on this matter is, of course, based upon a man's experience, and as no two territories carry exactly the same kind and class of traffic, it is readily seen that either of these estimates might be correct for the individual case, although the higher estimate could only be used for city traffic, where police control is constant, and the lower can only be justified adjacent to a city where the peak loads are abnormal. Any two-way highway could carry safely and speedily more than 10,000 vehicles per day, provided we could distribute this traffic uniformly over the 24-hour period; but no such uniformity now exists or ever will exist, and the highway must be provided to take care of peak loads.

As an extreme case, we can take a street in the city which carries the majority of the automobile traffic. Such a street will carry a peak load between 7:30 and 9:00 in the morning and between 4:00 and 6:30 in the afternoon far in excess of the other portions of the day. Also, a suburban road adjacent to a large city, along which the residents practically all do business within the city, would carry similar traffic. On the other hand, a business street of the city may show nearly as high or even higher total traffic than the one before mentioned, yet have no peak load equal to the road outside the city. As we get further from the urban community the traffic becomes scattered and we find ourselves compelled to consider the connecting pavement (before referred to as a part of our system) as required by the cities rather than by the territory through which it then passes.

The system of highways of a state or of the federal government is composed of roads outside of large centers of population, where police control normally is weak or entirely absent. The law permits a greater speed upon these roads than the city ordinances permit (upon some there is no legal limit, and upon all no actual limit), and this is as it should be. This speed condition must be recognized and the designer must bear in mind that speed with safety is to be secured. Many states which had definite speed restrictions written into their laws have modified or repealed them. Automotive manufacturers are constantly making speedier and speedier machines and drivers are using them. The driver of ten years ago was doing well on an open road if he rolled along at thirty-five miles an hour; today the same driver is doing forty-five and fifty miles an hour. This is not all of the story either—what about the high-speed truck and the bus? Forty, fifty miles per hour on the open road and impatiently blowing their horns

to scare the laggard thirty-mile-an-hour automobile out of the way. "Speed with safety:" that is why we have had to widen our country pavements, or highway system tracks, from sixteen to eighteen, to twenty feet for two-way traffic. This, and the fact that some states legally permit loads eight feet in width, and some clearance between vehicles is needed.

After having secured our physical basic data, as before outlined, we have made a fair start upon securing those things necessary for our system design, but there yet remains the collection of other data which are vital. Any plan involving expenditure for public works must be acceptable to the political officials—Congress, General Assembly, Board of Supervisors, County Commissioners, etc.—before funds can be secured for its execution. This side of highway design is more important than many engineers seem to realize. If the actual designer of the system does not have the necessary personal touch with the government, then he must be supported by some one who has the touch.

As the acquiring of the political data is frequently more difficult than the acquiring of the physical data, it should be started early, as many admirable plans for public improvements have failed or been long delayed because of lack of proper political support. Unconsummated plans are of little value, and many government "attics" are repositories for ideas on paper which need only to become a reality to be of value to the community, while others have beeen interred so long that their value is lost.

Therefore; study the traffic and arrive at a determination of its future possibilities; study the terrain for physical difficulties to be overcome and materials to be secured; study the community to estimate present and future possible classes as well as volume of traffic; study the governmental situation to predicate the fulfillment of the plan.

Highway Maintenance in New Mexico

State training school. Tandem maintenance. Nail pickers. Snow removal. A high-speed maintainer developed. Light oil treatment

By R. W. Bennett*

Conditions surrounding and controlling road maintenance in New Mexico are sufficiently complicated to intrigue the imagination of an efficiency expert, the brains of a financial wizard, and the resourcefulness of the engineer.

Fourth state in area, eighth in road mileage, 44th in basic wealth, with a population less than Washington, D. C.—add to these factors the topography of a Rocky Mountain state and you have the picture which confronts the maintenance engineer in New Mexico. Fifty-three hundred miles of gravel and earth graded roads must be effectively maintained for the motoring public—a distance as great as from New York to Portland, Oregon, thence down the Pacific coast to Los Angeles, and over the southwestern mountains to Albuquerque—on $200 per mile per year.

*Office Engineer, New Mexico Highway Department

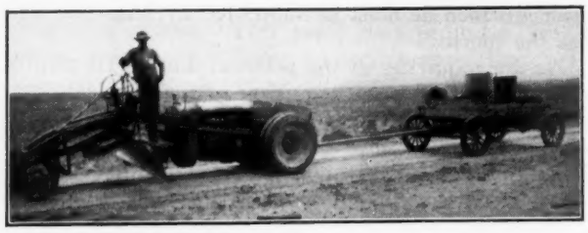
All Federal aid roads, U. S. Highways, and principal state routes are maintained directly by the State Highway Department. Funds for maintenance are provided by motor vehicle license fees, of which the state receives two-thirds the net revenues, and the five cent gasoline tax, the proceeds of which may be used for both construction and maintenance.

The patrol system of maintenance obtains in New Mexico—nearly one hundred patrols being necessary. Nearly all patrols are motorized; distances are too great to permit the use of horse patrols.

NEW MEXICO'S HIGHWAY TRAINING SCHOOL

The hub around which the entire maintenance organization rotates is the Highway Training School, located in the approximate geographic center of the state at Encino. Here men are trained for every phase of maintenance work and in care of equipment.

OIL PROCESSING ROAD BETWEEN CANONCITO AND PECOS, N. M.
Motor grader mixing gravel surfacing and oil, treating the road by the "turn over" or "mixed in place" method.



PATROL CREW CARRYING CAMPING EQUIPMENT, FOOD AND WATER ON TRAILER
Distances are great and houses are few in some parts of the State.

The Highway Training School, as developed in New Mexico, is believed to be an institution unique in America. The buildings of the school consist of shop, warehouse, office and dormitories for students. An area larger than an entire county is provided for the actual operations in which the students learn the work. Competent foremen, operators and mechanics are the instructors. Every variety of equipment used in the maintenance of roads is employed in order that the students may become familiar with each.

Students come to Encino from every section of the state for training. The course of instruction lasts from six to eight weeks. At the end of that time, if the individual shows aptitude at any or all phases of maintenance work, he is placed on the eligible list and a permanent place given him as soon as a vacancy occurs in the regular maintenance organization.

If the student shows that he is unfitted, by inclination or adaptability, for such employment, his service ceases with the end of his training period. Few failures are recorded after nearly two years of operation, the students being carefully selected.

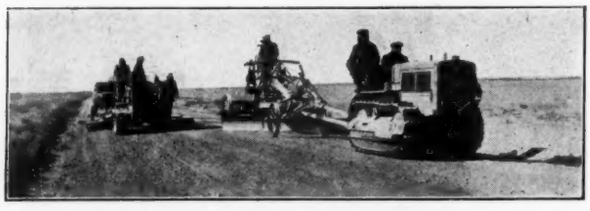
TANDEM MAINTENANCE

New and modern methods of maintenance are tried out at the training school district and, if found successful there, are adopted by the other four highway districts.

One of the methods put into general practice throughout the state during the past two years has been "tandem maintenance."

For tandem maintenance, two complete equipment units are used, one behind the other sufficiently far that traffic may move around both without any danger of collision. Each unit consists of a drag or maintainer with truck or tractor for power, or a combination tractor and blade operated by one man. Equipment is painted bright red as an additional factor of safety.

The advantages gained by the tandem method are greater speed; complete maintenance of roadway in one operation; and the elimination of the windrow of loose dirt, sand and debris which is left in the center of the road for a period of time when only one unit is employed. This ridge of loose material was a menace to the motorist and its elimination has reduced the number of accidents from this cause.



TANDEM MAINTENANCE
The two units have been moved close together for photographing, but they actually work several hundred feet apart to permit safe passing of traffic.

ACCIDENTS REPORTED BY MAINTENANCE MEN

All maintenance men are required to report promptly any accidents occurring on their patrols of which they can obtain knowledge.

These reports are very complete, giving the condition of the road, weather condition, cause and results of accident, personal injury or death, property damage and so forth.

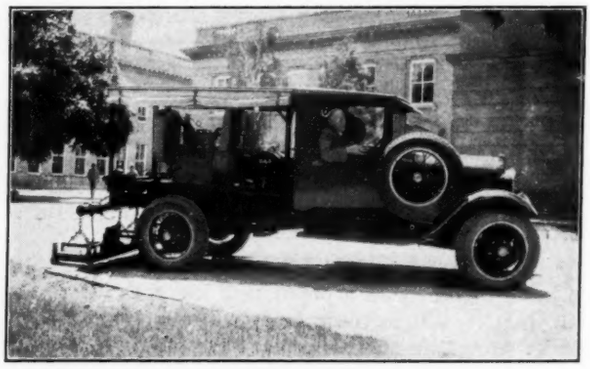
These data are compiled and analyzed carefully, and where the liability seems to be that of the road or the department, steps are taken to remedy the defect, whether it be faulty road design, narrow bridge or culvert, blind curve or carelessness of employees.

Educational work and publicity are constantly employed for the purpose of reducing as far as possible the number of highway accidents.

THE NAIL PICKERS

An unusual practice was instituted by the department last year in connection with its maintenance "public service" program.

A powerful electro-magnet and generator mounted on a light truck, designed to rid the state highway of nails, tacks, screws and other metal puncture menace,



A NEW MEXICO METAL-SWEEPER OR "NAIL PICKER"
Electro-magnets at the rear are powered by motor and generator mounted on light truck.

was built by the Spring and Forging Company of Roswell, especially for the Highway Department.

The tests made with the first metal sweeper were so successful and the operating costs so low that three more of these machines were ordered, built and put into service—one in each of the four highway districts of the state.

The benefits resulting from the use of the "nail pickers," as they are popularly called, have been marked. Motorists report that punctures resulting from nails and other metal objects have been reduced at least one half.

The four machines are able to cover completely the 5300 miles of maintenance roads about four times each year. It is necessary to make two and sometimes three runs to completely cover a road and rid it of metallic objects. Over 90% of such material is removed. On initial runs the machines picked up an average of eight or ten pounds of junk from each mile of highway covered.

SNOW REMOVAL

Although New Mexico, as a whole, is not subject to as great snowfalls as the more northern states, yet in the northern portion and in regions of high alti-

NEW MEXICO MAINTENANCE PATROL CREW BUCKING SNOW WITH A WING PLOW AND TRACTOR ON THE RATON-TAOS ROAD.

tude, mountain passes and roads frequently are visited with heavy snows which obstruct travel.

The present day practice of "keep the road open" obtains in New Mexico as well as in other states. To combat the snow several plows were purchased and placed in operation during the present winter season.

The result has been less inconvenience to motorists who find it necessary or desirable to travel in the winter season; routes have been opened up promptly which formerly took a matter of days, and traffic is heavier during this season than has been the case in former years.

HIGH SPEED MAINTAINER DEVELOPED

The long patrols and limited funds for maintenance operations have led to the introduction of many new features in road maintenance in New Mexico.

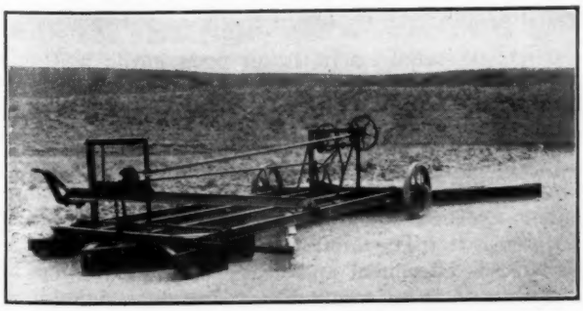
The great portion of the state's maintained roads are of gravel or graded earth types. Because of lack of finances, less than 80 miles of concrete roads have been constructed.

The maintenance of these gravel and earth roads has presented problems peculiar to this semi-arid region. Long spells of dry weather render efficient maintenance very difficult. Frequent dragging is essential.

The greatest rate of speed obtained with the ordinary road drag or maintainer powered by truck or tractor, compatible with an effectively maintained road surface, has been four miles per hour.

The department, in cooperation with Col. H. R. Andrew of the Spring and Forging Company of Roswell, New Mexico, last year began some experiments leading to the design and construction of a lighter, faster and more economical gravel and earth road maintainer.

The first machine designed and built was a marked improvement over previously used maintainers. Its weight was 2500 pounds with extension blades. While constructed along the general plan of most commercial maintainers, the principal difference lay in the arrangement of the blades. They were built in the form of a letter V, vertex forward, and at an angle of approximately 30 degrees instead of the usual 45 degrees. The result was that it could be operated efficiently at a speed of eight miles per hour without vibration or chatter—an almost 100% improvement over the machines previously used.



HIGH-SPEED MAINTAINER RECENTLY DESIGNED FOR USE ON NEW MEXICO GRAVEL AND EARTH ROADS. Capable of efficient maintenance when operated at a speed of 12 miles an hour.

Not content with this accomplishment, a second machine was designed and constructed, 400 pounds lighter than the original one. The same arrangement of blades is used. To overcome the tendency to vibration in such a light drag, three stabilizer blades were built into the machine, two at front, one on either side, and one at the rear center—all vertical and parallel with the roadway. These stabilizer blades are controlled by foot levers located near the operator's platform. When the maintainer indicates a tendency toward side sway or chatter, the operator applies the right pressure to the blades and the vibration immediately ceases.

The new maintainer has been subject to many tests and has proven successful. Less power is required for its operation, a 1½-yard truck being able to handle it readily. The average speed obtainable with the high-speed maintainer is from 10 to 12 miles per hour —even 15 or 18 under favorable soil conditions.

Two such units working in tandem can completely, efficiently and economically maintain 80 to 120 miles of road per day.

OILING PROGRAM UNDER WAY

The rapidly increasing volume of traffic on New Mexico highways, particularly on the transcontinental and trunk routes, is making maintenance and replacement on these gravel roads very costly if not prohibitive.

To offset the loss of gravel surfacing sustained by reason of heavy traffic, dry climate and high winds, some method of treatment was necessary or New Mexico's gravel roads would be lost. Department engineers, after careful investigation of its results, finally adopted the light oil treatment used by California and a few other states as offering the most economical solution of the problem. Last year 100 miles were resurfaced and treated with road oil by the "turn-over" method developed in California.

The results have been very satisfactory; road dust is eliminated; loss of gravel surfacing is reduced to almost nil; maintenance costs cut very materially, and the motoring public is provided with an excellent non-corrugated riding surface, neither slippery in cold weather nor soft in summer.

It is planned to oil-treat all gravel surfaced roads on Federal and U. S. routes just as rapidly as funds will permit. The cost of oil processing has been from $1500 to $1600 per mile. Where the old road metal is worn thin, it is necessary to add gravel to form the oil mat—usually about 3 inches in thickness and 18 to 20 feet in width, costing from $1500 to $2000 per mile.

Nowhere is versatility in the highway engineer more necessary than in New Mexico, where funds are short and roads are long.

Asphalt Repairs in Syracuse

In his report for the year 1928, Nelson F. Pitts, Jr., city engineer of Syracuse, N. Y., states that

maintenance and repair work on asphalt-paved streets was carried on far more systematically and more promptly during that year because of the "purchase of the mobile asphalt repair plant at a relatively small cost. Previous to the acquisition of this plant, it had been the custom, after the five-year guarantee had expired, to let out repair work to contractors. It was found that the contractors were not willing to move their machinery for the repair of small defects and holes; so the system was discarded in favor of a municipally owned plant.

"A thorough system of inspection is maintained by the division, which receives information as to needed repairs not only from its own employees but from the police, interested property owners, and citizens in general. When trouble is reported, the plant is put into operation and the repair material transported quickly to the site, where the defect is remedied rapidly and efficiently. This has added greatly to the life of pavements, as the holes and defects caused by ordinary wear and by cutting for substructures had not been allowed to stand and thus increase."

County Highway Problems

Adequate improvement and maintenance of roads and bridges with limited finances is the basic problem. Constructing and maintaining timber bridges. Machining and ditching roads

By J. F. Coleman*

The usual county, with its proportionately high road mileage and relatively small income, today faces one of the most difficult of all highway problems. The demand for adequate roads and bridges caused by the rapid growth of rural population and activities, is one which the counties can not meet with their limited finances and facilities.

It is often more of a problem to decide on a program and a schedule of work that will benefit the county as a whole than actually to carry it out. From every quarter come insistent demands for roads, some of them of county importance and others purely local or private. If the elected county officials wish to remain in office, they must consider the demands of their constituency, and this applies not only to purely political office holders, but also to those to whom holding office is secondary to their desire to improve highway conditions, and the point to which he carries satisfying his supporters often distinguishes the good from the poor official.

This consideration of the wishes of the constituency has such a direct influence on the formation or lack of formation of a highway policy and program that it must be given prominence in any consideration of county highway matters. The county organization is a more intimate affair than that of a state department. If John Jones, in the first district, has asked that a certain piece of work be done and the road crew is sent somewhere else, Mr. Jones soon finds out about it and walks into the office of the county commissioner (whom he probably has known all his life) and wants to know why in the Sam Hill this is so, etc. Under such conditions, it is difficult to formulate a schedule and still more difficult to adhere to it; but ability to do so is the most important and economical thing in the prosecution of high way construction or maintenance.

In laying out the program, the most important roads in the county, and there is left to the county officarried through without digressing to any less important jobs. It will take only a short while for systematic work to show results, while small jobs here and there make no impression.

The taking over of county roads by states has both its advantages and disadvantages. It relieves the counties of the burden of maintaining the heaviest-traffic roads; but these were usually the best improved roads in the county, and there is left to the county officials the dreary prospect of maintaining only miles of dirt roads and bridges more or less in need of repair. On the other hand, the state has usually introduced a higher standard of both construction and maintenance to serve as a model and encouragement to the county commissioners and compelled them to meet the question why they can not do as well as the state. (In some cases it is the state officials who have to explain why they can not do as well as the counties.)

Most counties, having extensive mileage and small funds, should limit their program to gradual betterment through improved maintenance rather than concentrating expenditures on construction of a mileage of roads necessarily so small as to be of no real benefit. Other counties will have funds permitting of limited construction programs in conjunction with maintenance work; while a few can carry on construction programs of considerable extent by selling county bonds or otherwise. To which ever class a county belongs, it must prepare a fixed program and adhere to it, else there will be a jumble of loose ends of unfinished work instead of a real accomplishment in completed projects.

The first requirement is an open road; and this means adequate bridges, for a road blocked by high water is no road at all until the water goes down. Next in importance is drainage—culverts, pipe and side ditches. Following this, an all-weather surface, which may be of dirt, clay, gravel, or paving, maintained as such by proper drainage and intelligent maintenance. The final consideration of major importance is alignment and grade. On heavy through-traffic roads these would be of first importance, but the usual county road is more of a local affair and, while its curves and grades may be dangerous, still they are well known to the public using them and can

*Maintenance engineer, State Highway Board of Georgia

WHEN THE WATER CONTINUES RISING, THIS BRIDGE MAY BE LOST IF SET ON MUD SILLS, BUT IF OF DRIVEN PILES, NO DAMAGE WILL BE DONE.

be negotiated safely and should certainly be considered only after the bridges and other structures have been provided.

BRIDGES

For a successful road system, bridges must be entirely adequate, and money spent on any but the most urgent work until proper bridges are obtained is money spent unwisely. Where foundations are necessary, they should be built with future heavier construction in view. If often happens that, where long approaches are necessary, financial considerations necessitate a choice between the alternatives of, first, building standard bridges with sufficient opening and proper elevation but postponing all or nearly all of the approach fills, merely ramping up to the bridge ends so as to make them serviceable; or, second, building the fills up to proper elevation, and constructing temporary bridges; or, third, making the bridges permanent below the high water mark and bringing up the fills accordingly. There should be no hesitancy in selecting the first method, for the bridge itself is the major consideration in the new road, and leaving the fill temporarily at the level of the old road will work no additional hardship on the public, and this plan will ultimately give a permanent and satisfactory crossing.

Owing to the great number of bridges required by the usual county, and their costs, I believe creosoted timber bridges with driven piles are satisfactory, as they have an indefinite life if the floors are properly protected and the connections kept tightened. Bridge bents should never be set on mud sills, for the cost of piles and the delay due to driving them are more than offset by the more stable foundation. Both alignment and grade should be established by an engineer and pile cut-off at least should be given by an instrument. Piles can be sunk rapidly and economically in any soil where wood piles can be driven without injury by use of equipment consisting of a 2,000-pound hammer, 200 feet of ¾-inch steel cable, two 12-inch sheaves and a 2-ton to 5-ton truck or tractor, with leads that can be built in a day. Such a rig using a 5-ton truck will drive piling in sand or similar soil for 20c per lineal foot of penetration, this cost including foreman at $5.00 a day and seven men at $3.00 each per day, with the necessary gas and oil for the truck; but does not include the cost of piles or expense of setting up rigs or transporting piles to the job, all of which vary too much to be considered in a general statement. This would make a 30-foot pile at 12-foot penetration cost 8c per foot of actual driving. These figures are averages over a long period. Greater speed and additional economy may be obtained by converting a small tractor motor into a pile-driving rig by the addition of one or two winding drums; or regular driving rigs can be bought for a few hundred dollars; which can be set on skids independent of the driver, or mounted as part of the supporting frame of the driver itself. While greater speed and economy can be had by this rig, and its use is recommended for long bridges, still, on account of the greater mobility and ease of movement, the truck is greatly to be preferred on numerous short jobs as it will transport all equipment and personnel so that, when it arrives at the job, everything necessary is there to begin driving, there being no heavy, cumbersome equipment to knock down and set up at each move.

When using a long cable with the truck rig, it would save time and labor of men pulling cable slack, to attach sufficient weight just above the hammer hook to take up the slack and pull the hook down as the truck comes in after each hammer blow; about 300 pounds, depending upon the cable length, will be sufficient. Additional room for this weight will have to be anticipated when constructing leads. Bushing the sheaves and putting pressure grease connections on them will save a lot of trouble. A 3-foot or 4-foot hole dug with a post-hole digger or shovel, to start the pile in, will be of great help, increasing the height of the first few blows, decreasing the time of driving, getting the pile started straight, and allowing longer piles to be used in the leads.

Bridge Maintenance—Bridges should be inspected throughout twice a year, and for scour around bulkheads and bents after every high water. The approaches should be kept smooth by all means, for stresses set up by the impact of heavy, fast-moving loads on an uneven bridge approach will soon cause failure.

Bridge floors should be kept clean to insure proper

THIS RIG WILL DRIVE THREE FOUR-PILE BENTS A DAY. THE MOTIVE POWER IS A "SKIDDER," USED FOR HAULING LOGS FROM SWAMPS, WITH ABOUT 300 FEET OF CABLE.

BRIDGE APPROACH PROTECTED FROM WASH

drainage, this being especially advisable on wood floors, as dirt or trash will hold moisture and cause rot. Hand rails, if of untreated materials, should be kept painted. Bolted connections should be examined and tightened once a year. Flooring should be kept nailed tightly, as a loose plank will not only quickly wear out, but will soon injure the joist. On treated timber bridges, cracks which appear in any member deep enough to extend below the point of treatment should be filled with hot creosote oil, and holes left by extracted nails and bolts should be treated the same way.

Protection of fills at bridge abutments is cheap insurance, and one of the cheapest and most effective methods of affording such protection is to rip-rap with bags filled with a mixture of 1 cement to 5 or 6 sand, placed on a 1½ to 1 slope and extended along the slopes of the fill for a distance of 25 feet away from the bridge. The first high water will cause this mixture to set and leave a practically impervious and highly protective rip-rap at low cost. The bags of cement and sand should be staggered and mashed and stamped firmly into place so that there will be as few openings as possible. It is an advantage if they can be placed as the water rises, as the joints can be more nearly closed if the bags are compacted while wet.

Weak and dangerous trees close enough to cause damage should be cut, and trash drift, etc., collected near bridges should be cleared away in dry periods as a precaution against fire. Of course, drift on the up-stream side is dangerous in high water and should be removed immediately.

MACHINING AND DITCHING EQUIPMENT

A county which can afford only one tractor should have a 10-ton, and one or two 12-foot grading machines equipped with a back sloper and scarifier. If two tractors are owned, one should be a 5-ton with a 10-foot machine with back sloper and scarifier. If other tractors are purchased, they should be 5-ton, unless ditching or other exacting work requires an additional 10-ton. The day-to-day grind of highway work is, I believe, slightly too much for the smaller working parts of the 2-ton; also their overhaul and parts cost nearly as much as for the 5-ton, and the necessity for them comes oftener.

If a section of good gravel or similar surface under moderately heavy traffic is to be maintained, a one-man power wheel grader is the ideal equipment, as it is fast and inexpensive to run and, on account of its longer wheel base and susceptibility to manipulation, is much to be preferred to a truck and drags, and is just as efficient and less expensive than a tractor or truck and grader. Wheel types, cleated or otherwise, are not recommended for a surface that becomes slick in wet weather or deep in sand in dry weather. A one-man power grader with crawler attachment will be very useful, but will not do satisfactory ditching or scarifying.

In buying a 10-foot or 12-foot grader, a back sloper and scarifier should be purchased by all means. The back sloper is the most useful attachment that can be secured and it is a serious mistake not to buy it and use it after purchase. It has three distinct and major advantages in ditching over the blade alone: First, a wider ditch can be secured; second, surplus dirt may be pushed out in well worked up ditches, or pulled in as desired; third, a slope may be given to the back side of ditch so that it won't fall in and fill up the ditch after the first few rains.

The use of a back sloper requires little more time than the use of the blade alone, but it does require the back side of the ditch to be free from trees, stumps,

DITCH, MADE BY BACK-SLOPER ATTACHED TO A TEN-FOOT GRADER, HAS SATISFACTORILY WITHSTOOD A VERY WET WINTER

etc., as one end of the sloper rides against the back side of the ditch and in low cuts extends up beyond it. However, this should be a minor consideration when all of its advantages are taken into account. After a ditch has once been well opened and well worked out by a 10-ton outfit, it can easily be worked thereafter by a 5-ton outfit. By going into the ditches a few extra times, they can be worked out very satisfactorily by a 5-ton outfit in the beginning.

The enormous mileage in most counties compared to equipment makes it impossible to cover all roads more than two or three times a year, although a few sections may be covered more frequently. This makes it obligatory to leave behind as stable a job as possible, and no one thing will give greater stability than adequate ditches free and open. Ditches of this kind cannot be secured more easily and economically than with the use of a back sloper.

The scarifier will be of great use in both construction and maintenance. It is very effective in breaking up a newly graded road so that it may be machined to proper section, and it is also valuable in tearing up sod, small roots, etc., in clearing right of way.

In maintenance, its use would come from the fact that roads can not be machined as often as they should be, neither can maintenance crews add fresh mate-

rial whenever waves, holes and depressions show up; consequently the surface gets so out of shape that machining can not put it back again and it must be broken up by a scarifier and reshaped to proper cross section by again blading the loose material.

But it is not recommended that a scarifier be used where proper patching materials have been available and there has been reasonble time to place them and for frequent machining; for scarifying undoes the very thing that is the aim and purpose of proper maintenance methods, by breaking the bond of the base and making it necessary to keep it reshaped until again compacted by traffic, and also renders it more susceptible to moisture, thereby throwing an additional burden on the machining equipment. It is only when it has been impossible to employ proper maintenance methods that the use of the scarifier is justified.

MACHINING SURFACE

The county highways, like those of the states, are presented to the public principally through the comfort and safety afforded by their surfaces; and these depend chiefly on machining. The most common fault in machining is leaving a roll of loose dirt mixed with trash, etc., in the center of the road. This is a very dangerous practice and I know of several deaths directly attributable to it; a car going at high speed hitting this ridge of loose material with one wheel is very often thrown entirely across the road to land in the opposite ditch. Moreover, it narrows the road by creating about two feet of center that cannot be used, which on most county roads is a serious thing; it builds up a too high crown, which is dangerous in wet weather if clay is present, as well as creating an uncomfortable riding surface; all the loose nails and other objects likely to cause a puncture are confined to this one small space and if, as sometimes happens, one is compelled to drive in the center the chances of damage to tires are greatly increased; and finally, this method of machining does not conform to the best practice, nor is it best suited to build up the surface and give the best satisfaction generally.

All roads that require machining should have the loose material carried from one shoulder across the road and feathered out on the opposite shoulder. This method will preserve the proper cross section of the surface and do every necessary thing that pulling both ways to the center will do. Some very pretty work can be done by machining both ways to the center; but, however smooth it may look, the surplus loose material will always be there.

A WELL-MACHINED EARTH ROAD. NO RIDGE OF LOOSE MATERIAL AT CENTER OR SHOULDERS

No county will ever have a successful road system until the mule and 7-foot or 8-foot machine is replaced by the tractor and the 10-foot or 12-foot blade; this is especially true of the low-monied, high-mileage counties.

LARGER EQUIPMENT

It has been demonstrated beyond discussion that the day of hand labor in road construction is past. When a small dragline, steam shovel, or string of automatic wheelers will handle material so much more quickly and economically, it is folly for a county with any extensive construction program to stick to the slower and costlier hand work. Some counties, because they normally maintain a large force of cheap labor, imagine they are doing economical work when this whole force is taken from all other work to concentrate on one important construction job. In reality, they usually have so to neglect their maintenance and betterment work that the loss more than overbalances all gain from the construction so performed.

The use of a dragline, steam shovel, or automatic wheelers will allow the bulk of the labor to be spread out over a considerable area on maintenance and betterment work, and the machinery with only a few men will accomplish a great deal more than a large hand force alone or working in connection with horse wheelers. The machines will do all the heavy, rough work, leaving only light finishing for hand and wheeler outfits, which can be done without sacrifice of other necessary work.

The choice of equipment will depend on type of country. Generally, draglines are best for low country where long fills are necessary; they are ideal where the ditch excavation will build the road bed in low, flat country. Steam shovels are best in mountainous sections and are at their best in side-hill work. Automatic loading and dumping wheelers give splendid results in rolling country where the hauls are reasonably short and they can work two cuts to a fill, making turns on fills unnecessary. Automatic wheelers are not recommended where a great deal of solid rock is to be handled, but they will handle loose rock in connection with earth very well. One 10-ton tractor will handle seven or eight wheelers in very loose material, five or six in medium hard clay and sand-clay, and four or five in hard material or on soft footing.

CARE OF EQUIPMENT

The chief complaint heard against the use of equipment is directly traceable not to any fault of the equipment itself, but to the neglect of it by operators. Modern equipment is almost always good, but it can last only a short while under neglect and improper treatment. Choose your operators carefully, pay enough to get competent ones and keep the same men on the same equipment if possible. See that they understand and put into practice the proper methods of care and operation, and there can be no question about the equipment giving satisfaction.

ENGINEERING

A suggestion I would like to see put into practice, and one I am sure would be of great value to county

highway work, is to have an experienced highway engineer assume direction of their highway activities. Qute a number of counties have done this, but the great majority have not. If a county feels that the cost of an engineer is too great a burden, they could arrange with one or more counties to share an engineer's expense and services with them. If only a 20-foot bridge is to be built, or a mile of road to be improved, how much better it would be to know surely that the drainage, elevation or section is correct and that future needs and possibilities of ensuing construction have been anticipated, than to have done it haphazardly without proper regard for anything but to get it done. Construction should be for permanence; maintenance should have betterment for its ideal; both need trained and experienced engineering guidance for fulfillment.

Schenectady Sewage Treatment in 1928

Problems caused by discontinuance of flow to plant while cleaning trunk sewer. Farmers eager for sludge

The most important feature connected with the operation last year of the sewage treatment plant of Schenectady, New York, as described in the annual report of Morris M. Cohn, the sanitary and testing engineer of the plant, was the cleaning of the main trunk sewer and the intermitting of treatment of the sewage necessitated thereby.

This trunk sewer, which has a box section, 6 feet by 3 feet 7 inches, had not been cleaned since it was first placed in service 13 years before. This sewer and about 2000 feet of a 42-inch interceptor had accumulated great quantities of heavy grit and organic sludge, which had a serious effect on the pumping station and the treatment plant operation. This trouble was due largely to the entrance of excessive quantities of storm water into the sanitary lines through improper catch basins and roof leader connections, and through ground water infiltration, which resulted in fluctuations in flow as well as in the deposits. The entrance of this storm water was proved not only by the great increase in flow during storms, but by the type of street wash caught by the bar rack at the pumping station.

As it would be impossible to continue to purify the sewage while these sewers were being cleaned, Mr. Cohn obtained from the State Health Board the declaration of an emergency and permission to discontinue treatment while cleaning was in progress. As a result of this, the pumping station and treatment plant were in service but nine months of the year. The work of cleaning was started on March 29th and the sewer was again put into service on July 10. This, the largest piece of sewer maintenance work ever attempted in the city, was carried out at a cost of slightly more than $9,000.

Accumulations of heavy grit and sludge had built up to a depth of as much as 24 inches in the 42-inch circular interceptor and a depth of 20 inches at many points in the trunk sewer. It is estimated that about 2100 yards of this compacted material was removed in the cleaning. The work involved the construction of ten new manholes in the roofs of the trunk sewer and interceptor, the building of two new relief manholes and shunt lines to care for the diversion of sewage flow from the trunk line during the cleaning period, and the cutting of two flushing holes in the trunk wall and the subsequent sealing of these holes and of all other defects found by careful inspection of every foot of the two sewers.

It was found impossible to clean the lines by mechanical means, owing to the compactness of the deposits, scant headroom in the conduits, and the inaccessibility of the largest portion of the rectangular trunk to heavy equipment. The entire length of the interceptor was cleaned by hydraulic flushing of the material to sandbagged manholes, and removing the solids to the ground level by buckets. Much solid material also was flushed from the interceptor through the diversion lines mentioned above. The first 4000 feet of the trunk sewer was cleaned in the same manner, but, due to the absence of city water along the lower stretch of the conduit, new methods had to be attempted. Two flushing holes were cut in the side wall of the trunk sewer down to the level of the sewer invert, and the pumps at the station were run at double the normal pumpage rate for the purpose of driving alternate flushes of sewage through the line. This procedure, coupled with the loosening of the most compact part of the sediment by men equipped with rakes and hoes, resulted in the complete clearing of this section, both rapidly and economically.

During November, the trunk sewer was entirely shut down for three days for the purpose of permanently sealing the two flushing manholes, which had been boarded up temporarily at the finish of the cleaning work; which also permitted a thorough survey of the trunk line after four months of service. Evidence of new deposits was found but the amount of the accumulation was slight.

While the cessation of flow of sewage into and through the Imhoff tank for a period of about three months was beneficial in that it gave the tank a rest, it was also dangerous with regard to odor production, and excessive care was taken to prevent odors. The tanks were hosed day and night to keep the surface free from floating scum. Intensive hosing of the gas vents was started to break up the scum blanket that had built down to the plane of the slots and had sealed them. Slicing bars were used in the slots to force an opening through which solids could enter the digestion chambers. Sludge drawing was carried out as rapidly as ripe sludge was available, despite the fact that the absence of incoming sewage resulted in the drawing down of the level of the liquid in the tank, but fresh water was immediately used to replace such loss in volume. The tanks soon assumed normality and as soon as the usual duck-weed began to form on the surface, the units were left undisturbed. No odors of any sort emanated from the tanks.

Psychoda began to breed in large numbers in the gas vents and in the stagnant tank channels. The application of hypo to each of the 144 vents and the application of a coat of oil and crude carbolic mixture to every sedimentation compartment resulted in rapid eradication of this condition.

Although the tanks were not receiving sewage for a period of three months, the amount of wet sludge drawn was 7,166 cubic yards, which was within 50 yards of the amount pumped during the previous year. However, the sludge had a higher moisture content and the amount of dry solids was therefore considerably less than the previous year. The pounds of dry solids in 1927 had totaled 978,000, while in 1928 they totaled 678,000, or about 30% less. A reduction in sludge quality during the last month of the drawing season indicated that optimum balance between ripe sludge and incoming solids had been upset by the intensive sludge removal program. This, however, was necessary if room was to be provided for winter storage, the sludge space in the Schenectady tanks being considerably less than is desirable.

Taking the averages for the year, the treatment in the tank resulted in the removal of 70.3% of suspended solids, 56.6% of suspended albumenoid ammonia, and a "theoretical efficiency," or removal of settleable solids, of 85.9%. Taking the monthly averages, the removal of settleable solids did not during any month fall below 80% and in January and February was over 90%. The tank effluent averaged for the year only 49 parts per million suspended solids.

The accumulation of data on the temperature of the solids in the sludge compartments of the Imhoff tanks was continued during the year by means of a Foxboro recording thermometer installed through one of the vents into the bottom of the tank. Temperature changes were very gradual and lagged considerably behind atmospheric temperature changes. The sludge compartment material reached its lowest point of 47° F. in January and its maximum of 74° in August; monthly averages ranging from 50° in the former month to 69.5° in mid-summer. The sludge temperatures were always several degrees higher than those of the incoming sewage or tank effluent.

SLUDGE DISPOSAL

During the winter of 1927-28, all trash collected by the bar rack was stored, and finally disposed of by shallow trenching in the spring just as the frost left the material. Summer screenings were plowed under the soil. Efforts to interest the farmers in the screenings for their land were not particularly successful. The presence of excessive quantities of rag and waste imposed operating difficulties on the tank appurtenances and sludge pumping equipment. Garbage thrown into the sewers by householders gives trouble at the plant, since it is largely of a floating nature and plugs effluent screens or goes over into the filter distribution system.

We stated a year ago, in our analysis of the 1927 report of this plant, that a large part of the 1927 sludge production remained in storage at the beginning of the winter due to the early coming of cold weather and snow. In the spring of 1928 every cubic yard of sludge was sold from the field and farmers cleared the entire 38,000 square feet of drain area of approximately 3½ inches of sludge cakes, raked the beds in search of more fertilizer and even scraped up old weed-overgrown sludge that had been lying around since 1924. Many farmers were disappointed in the small quantity they could obtain.

Comparing the depth to which the sludge was run onto the bed, 10 inches, and the depth of the final air-dried sludge removed, there was a shrinkage of about 70%; while that removed to the fields shrunk still further during the summer months. This shrunken sludge on the field was removed by the farmers as well as that from the beds. This is the first year that all stored sludge was hauled away before winter arrived. Farmers are warned against the use of sludge on any crops that grow in or on the ground and go to the table uncooked.

TRICKLING FILTERS

The interruption of application of sewage to the filters came during the months when the beds usually show a marked increase in nitrification efficiency; moreover, during a large percentage of the nine months of operation, the under portion of the filters were flooded as a result of rises in the river level, which prevented aeration of the beds from below. The filter underdrainage system was flooded a total of 236 days or approximately 65% of the time, while during eight days the beds were flooded for the purpose of fly control. However, excellent nitrification was maintained during the winter and spring, and the beds returned early to peak production of oxidized nitrogen after the shut-down period, which bespoke a healthy condition in the units. The stability of the filter effluents average well over 80% for the year. The free ammonia content of the applied sewage was reduced from a yearly average of 12.7 parts per million to 4.6 parts per million on one set of beds, to 5.4 parts per million on a second set, and to 5.8 parts per million on a third; an average reduction of 60% for all beds. Owing to the adverse conditions referred to, the quantity of nitrates and nitrites in the final effluents ranged from a maximum of 9.5 p.p.m. to a low of 1.2 p.p.m. The filters reduced the biochemical oxygen demand of the tank effluent by about 67%.

As in previous years, the amount of suspended solids in the final effluent exceed that in the tank effluent applied to the beds. The latter contained an average of 49 parts per million while the final effluent averaged 62 parts per million. It is evident that for the past few years the beds have been passing out an accumulation of previous years. Improved bed efficiency indicates that this clearing of the interstices is beneficial and conforms with theories that the media with thin film is most able to perform its function.

Archorutus viaticus were more plentiful than ever, before the plant shut down, but during the resting period the "spring-tails" disappeared from the upper layers of stone. A flushing given to the underdrain system of one set of beds washed myriads of these insects out of the beds, and flushing of the other filters was not carried out in order to save these insects from destruction. It is evident that the archorutus had travelled deeper into the beds in search of film-covered stone as the upper stone dried out.

The Taylor round nozzles on trickling filter bed B were replaced with new distributors of the Worcester model and the old nozzles will be used to replace those broken in service on the other five filter units. This nozzle change has resulted in greatly improved distribution of the sewage on the newly fitted bed. During the past fall there was no ice formation on the surface stone of Bed B, while other filters showed more than 10% of their areas covered with shell ice. The Worcester nozzles have shown a lower tendency to clog and are more easily cleaned.

Results at the Pasadena Activated Sludge Plant

Under this title we published last month a description of the Pasadena, Calif., plant and results of five years of operation. Detail figures of February's operation and an airplane view of the plant were received too late to appear with the article and are given herewith.

Pasadena Sewage Disposal Plant: Operation During February, 1929.

Features of Operation	Average	Maximum	Minimum
Sewage flow, millions of gallons:			
Total per day	8.3	8.8	7.3
Four-hour peak	12.8	14.0	11.1
Peak	14.4	16.3	12.7
Air used, cubic feet per gallon:			
Total	1.7	1.9	1.4
Raw sewage	1.1	1.3	1.0
Detention period in aeration tanks:			
Hours, average	4.1	4.8	2.7
Hours, minimum	2.8	3.2	2.6
Detention period of returned sludge in reaeration tanks, hours	2.0	2.4	1.8
Sludge:			
% in aeration tanks, 30 min. settling	34	66	23
% in reaeration tanks, 30 min. settling	94	98	90
Million gallons returned	Estimated at 40% to 50% as much as total flow.		
Gallons filtered	289,000	418,000	76,000
Pounds of alum per 1,000 gals.	10.4	12.0	9.3
Pounds of Filter-cel per 1,000 gals.	9.7	11.7	6.9
Tons buried, dry basis	0.14	0.23	0.08
Tons dried	9.72	13.25	5.50
Clarifier sludge levels shown in feet clear water:			
No. 1—high	10	10	10
low	7	10	2
No. 2—high	10	10	10
low	6	10	3
No. 3—high	10	10	10
low	6	10	2
No. 4—high	10	10	10
low	6	10	2
No. 5—high	10	10	10
low	6	10	3
Chlorine:			
Total, pounds per day	138	158	117
Pounds per million gals., minimum	15.7	17.4	13.8
Pounds per million gals., average	16.7	19.2	14.6
Residual parts per million	0.16	0.20	0.12
Screenings:			
Total cubic feet	107	135	81
Cubic feet per million gallons	13.0	18.5	9.3

Chemical Results

Determinations	Average Raw	Average Effluent	Minimum Raw	Minimum Effluent	Maximum Raw	Maximum Effluent
Nitrogen as:						
Organic	28.8	19.8	34.0	24.0	24.0	14.5
Free ammonia	18.5	14.8	21.0	19.0	13.0	10.0
Nitrites	—	0.62	—	1.20	—	0.20
Nitrates	—	3.26	—	7.30	—	0.65
Five-day oxygen demand	190	8.4	300	20.0	90	1.0
Dissolved oxygen	—	3.9	—	4.5	—	3.1
Settleable solids; c c per l, 30 min.	8.6	0.2	11.0	1.0	3.0	0.1
Alkalinity	226	205	252	238	184	155
P H	7.2	7.1	7.5	7.2	6.8	6.9
Suspended solids:						
Total	428	11	764	20	304	6
Volatile	383	10	708	15	264	6
Fixed	45	1	56	5	30	1
Sludge:						
Liquid—Temperature	68.1		69.8		66.2	
Specific gravity	1.0037		1.0046		1.0024	
Moisture, %	99.30		99.50		99.22	
Dewatered—Moisture, %	78.39		79.43		76.93	
Dried—Moisture, %	3.59*		—		—	
Screenings: Moisture, %	83.82		87.52		78.53	

* Record for one day only—Feb. 7.

Summary of Weekly Log of Bacteriological Analyses:

	Average	Maximum	Minimum
Total bacterial count:			
Clarifier effluent	255,000	550,000	95,000
Chlorinated	375	550	200
Lactose fermentation:			
1 cc	5/5	—	—
0.1 cc	2/5	—	—
0.01 cc	4/5	—	—
B-coli:			
1 cc	5/5	—	—
0.1 cc	1/5	—	—
0.01 cc	1/5	—	—

One analysis of sludge gave—volatile, 66.87%; ash, 33.13%; nitrogen as N, 5.08%.

One analysis of screenings gave—volatile, 85.21%; ash, 14.71%.

Summary of Daily Log of Operation:

Large screen operated 24 hrs. every day.
Small screen not operated at all.

No. of aeration tanks operating: 29 on 14 days; 28 on 10 days; 27 on 4 days.

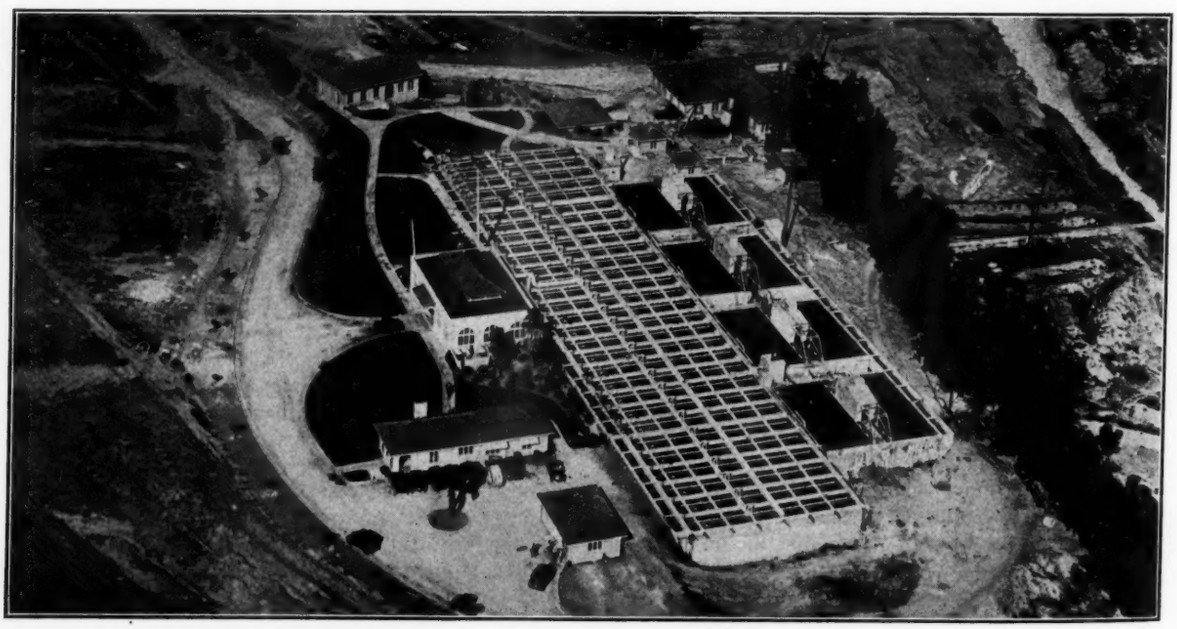
No. of reaeration tanks operating: 5 every day.

No. of clarifiers operating: 5 every day.

Hours filters operated: 24 on 18 days; 23¾ on 1 day; 19½ on 1 day; 14 on 3 days; 8 on 2 days; 7¾ on 1 day; 7½ on 1 day; 6⅓ on 1 day.

Hours dryer operated: 24 on 17 days; 23 on 2 days; 20 on 1 day; 13 on 3 days; 8 on 4 days; 6 on 1 day. (The dryer operated each day practically the same time as the filters.)

Cubic feet of air per day, millions of gallons: average 14.10; maximum 15.81; minimum 12.39.



AIRPLANE VIEW OF PASADENA SEWAGE TREATMENT PLANT

Concrete Sewer Laid in River Bed in Waterbury*

Several thousand feet of fifty-four inch pipe laid with joints almost absolutely water-tight at comparatively small cost. Construction details described

By Truman M. Curry, Jr.†

In Waterbury, Connecticut, a sewer project is under way (the first section being well along toward completion) which is of much interest because of the conditions, both physical and technical, under which it is being built. Probably the most unusual feature of the project is the fact that, from its connection with the old system to its terminus, the sewer is laid in the bed of the Naugatuck river. This location was selected because of its directness, and because the city thereby avoids the necessity of acquiring additional right-of-way. In addition, on the line chosen, the average depth of cut necessary is only 9 feet, as against 15 to 20 feet for any other feasible line, and there are no curves of less than 206 feet radius and one only of less than 420 feet.

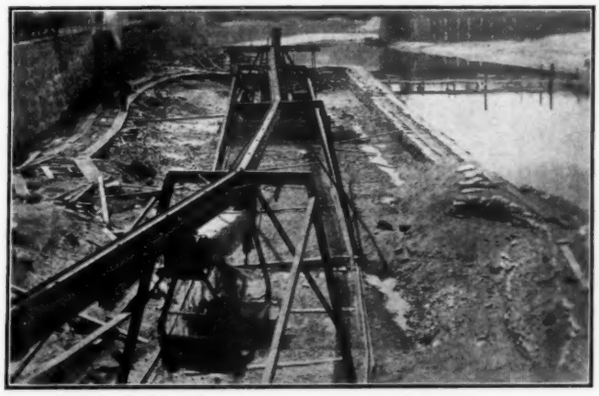
The new system was designed for a future population of 174,000, the estimated population of 1960. In planning the size required, the city was divided into fifteen sections and the trend of population in each section charted, the various sections presenting divergent problems of growth and expansion. Flow gaugings taken in 1926 of the sewage entering the river showed that the average per capita dry-weather flow was 85 gallons each 24 hours, including ground water seepage, and that the maximum dry-weather sewage flow was 170 gallons per capita. The average water consumption of the city proved to be 72.5 gallons per capita. While the survey was in progress, tests for acidity of the sewage made every 15 minutes for 6 days showed that no acids would reach the new sewer line.

Upon the findings of this survey, the capacity of the new trunk sewer was designed to handle a flow of 250 gallons per capita each 24 hours. Should the flow exceed this, branch sewer outlets will discharge the overflow into the river. The internal cross section of the old sewer, of which the new work is an extension, is 16.97 square feet. The old sewer is of monolithic concrete, horse-shoe shaped, and is laid on a grade of 1 to 1000, which provides a capacity of 47,400,000 gallons per 24 hours, using 95 per cent of the area. The nearest equivalent in precast pipe is the 54-inch, which, on the same grade, will handle a flow of 44,200,000 gallons per 24 hours using 94 per cent of the area.

A great deal of consideration was given the selection of the type of construction best suited to the situation. The structure had to be enduring and of sufficient capacity to serve the city for many years to come. At the same time, it had to be built at the lowest possible cost but without sacrifice of quality, endurance or service. Because the line was to be located for much of its length in the bed of the river, water-tightness was highly necessary, else seepage of ground and river water would lessen the capacity of the line and increase the cost of future sewage treatment. This location also brought the problems of shifting coverage, ground saturated to the maximum degree, and possible damage from moving objects in the river. Concrete was decided upon as best meeting these conditions, and pre-cast concrete pipe was chosen over monolithic concrete. One important reason influencing this selection was that only one-half as much trench was required to be kept open at one time, with consequent decrease in the amount of damage risked to the work by possible floods.

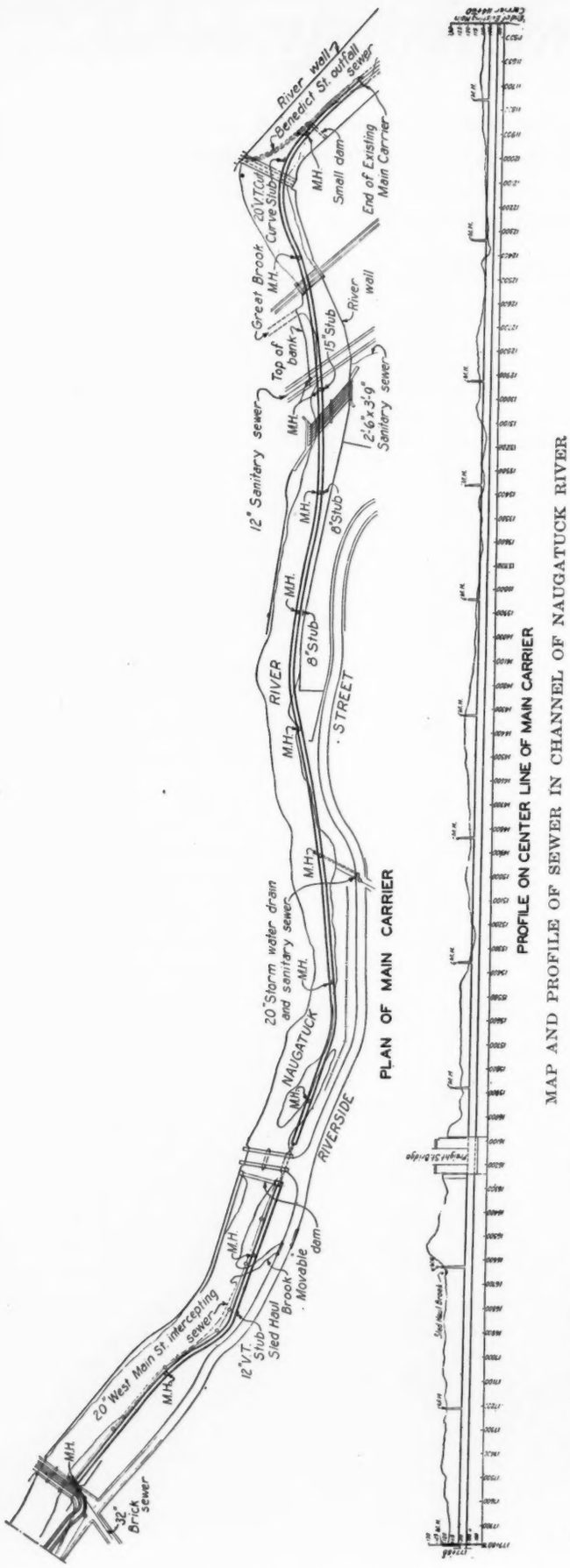
A contributing factor in the selection of concrete was the performance of the old concrete trunk sewer. This old sewer, of monolithic construction, had been in service 20 years. It has been connected with some of the largest brass manufacturing plants in Waterbury and carried off acid wastes as well as sanitary sewage for many years. Inspection showed the concrete to be in almost perfect condition, the only noticeable effect being some scouring along the center of the invert, probably caused by gravel carried by storm water flow during its first years when it was part of an auxiliary storm system.

Actual excavation began April 18, 1927, but was confined mostly to shallow work because of high water. Real progress began in June when openings were made at three points. Because of location in the river bed, and due to an unusually large number of heavy storms, rising water frequently delayed operations. To the end of the 1927 season the cofferdams and trenches were flooded twenty times, causing shutdowns of from one to ten days duration. The great New England flood of November 4 brought a rise of 14.8 feet and disrupted work for a period of six weeks.



EXCAVATING INSIDE THE COFFERDAM. THE SAND BAGS WERE PLACED DURING A PERIOD OF HIGH WATER

*Article and photographs by courtesy of "Concrete Highways and Public Improvement," organ of the Portland Cement Association. †Assistant engineer, in charge of the work.



MAP AND PROFILE OF SEWER IN CHANNEL OF NAUGATUCK RIVER

Cofferdams were built of sand bags and short wooden sheeting, possible because of the comparative shallowness of the river at normal low water. Two-inch tongue and groove spruce sheeting was employed in the trenches. Within the cofferdams, the trenches were excavated by "Moretrench" machines and steam shovels.

To control water inflow, a 12-inch pipe under-drain was laid with open joints in the bottom of the trench, and covered with crushed stone or screened gravel. This pipe remained permanently in place. With this drain pipe, 700 to 800 feet of concrete cradle and pipe could be laid before water backed up in the trench, at which time it would be necessary to prepare a new sump. Electrically driven centrifugal pumps, operating day and night, drew the water from the drain line at two points. Each pump was of 3,000 g.p.m. rated capacity and was driven by a 45 h.p. motor. In the great flood of November, the water rose so high and so rapidly as to submerge the pumps and electric motors, disabling the latter for weeks. Emergency gas engine pumps were used until the electrically driven pumps could be put into service again.

The old sewer built in 1906 extends from a site on the river held by the city for a proposed sewage disposal plant to a point 7,100 feet upstream. The completed contract of the new section runs from this point 4,600 feet further upstream, and a contract now under construction extends an additional 1,600 feet. Work contemplated includes a further extension upstream for 11,000 feet of 48-inch and 42-inch concrete pipe sewer, and a branch trunk sewer of 39, 36 and 30-inch pipe, 17,500 feet long.

The pipe units were manufactured by the Newark Concrete Pipe Company on the job, under the supervision of the engineer and in accordance with specifications prepared by him. All the pipe of the first two contracts is of 54-inch size, each unit being 4 feet long. The pipe lengths contain special steel reinforcing and were designed for a loading of 20 feet of cover, which allowed a generous safety margin over most of the line.

The greatest care was taken throughout all casting operations to secure a high degree of imperviousness in the concrete pipe. The mix was designed on a water-cement ratio basis using 6 gallons of water per sack of cement. The field mix averaged about 1-1¾-2¼ with the maximum size of the coarse aggregate limited to ¾ inch. The sand for the pipe was especially selected for its quality and was washed and screened.

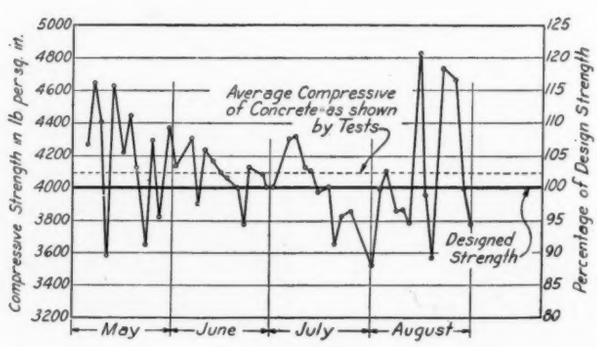


CHART SHOWING VARIATIONS FROM DESIGNED STRENGTH OF CYLINDERS CAST DURING MAKING OF PIPE.

A typical sieve analysis of the sand follows:

	Per cent Retained	Per cent Coarser
Retained on ⅜-inch sieve	0.00	0.00
No. 4 sieve	1.60	1.60
No. 8 sieve	6.05	7.65
No. 14 sieve	23.80	31.45
No. 28 sieve	37.20	68.65
No. 48 sieve	26.80	95.45
No. 100 sieve	2.80	98.25
Passing 100 sieve	1.75	
	100.00	

Fineness modulus 3.0305

A slump of 7½ inches was maintained by slight variation from time to time of the proportions of the aggregates, as this consistency was found to give, with proper spading, the best surface on the cast concrete. Each day, moisture content tests of the aggregates were made and the amount of water entering the mixer was corrected accordingly. A special water measuring device, built in accordance with the engineer's design, was installed on the mixer and was used throughout the job.

Six 6x12-inch test cylinders were cast every other day and were cured in the field under practically identical conditions with the pipe units. These cylinders were broken at seven and twenty-eight days. The mix was designed to give strengths of 4,000 pounds at twenty-eight days. The average strength developed was 4,090 pounds at twenty-eight days for the entire job. The maximum strength was 4,820 and the minimum 3,520 pounds. Inspection was directed with insistence toward seeing that the concrete was spaded thoroughly into the forms and that reinforcing was correctly located and kept at the proper spacing while the concrete was being placed. Thorough and even curing on all units was required and obtained.

A number of interesting features were developed in connection with the casting of the pipe. Early in the casting, some units were found to have inner and outer surfaces not truly cylindrical and some other units had spigots off center from the longitudinal axis to an extent beyond the close requirements of the specifications. These units were rejected. To provide against out-of-roundness of the inside surface, wood braces of 2 by 4's accurately cut to length were placed inside the shell, from bottom to top, across the opening in such manner as to form spokes inside the shell.

Around the outside of the outer shell forms, steel bands with turnbuckles were used. The bottom of the forms, of course, rested on and were held in correct position by the bell casting, and the inside braces and the outside bands. At the top, the casting which was to form the spigot was placed to rest upon the outer shell after the concrete had been placed to fill the barrel of the pipe. To prevent shifting off center of the top or spigot casting, steel spacers were wedged between the top of the inner shell and the inside surface of the casting, usually six spacers per unit being used.

After assembling of the forms, the steel bands were placed around the outer form and drawn tight. The reinforcing consisted of two lines of steel wire fabric rolled accurately to correct shape. The longitudinal reinforcement extended the full length of each section and well into the bell and spigot portions of the barrel. Transverse reinforcement was required to have a lap at least 50 times the normal diameter of the wire. Reinforcement was held in correct position during casting by pipe spacers placed vertically between the reinforcing rings and the forms. These spacers were drawn out as placing of concrete approached the top of the forms, usually about 6 inches at a move.

The mixer was placed at an advantageous position in the casting yard and the forms assembled in rows leading from it. A raised runway was placed to allow transportation of concrete. Concrete was usually placed between 10 and 2 o'clock. When the concrete had set sufficiently to allow the forms to be removed, usually early the next morning, the top casting and the inner and outer forms were stripped and moved into another line ready for concrete. Two sets of the bottom or bell castings were used.

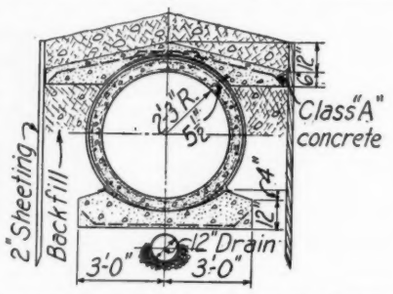
Particular effort was made to see that the high strength specifications and efforts to get good concrete should profit by proper curing. Over the rows of hardening pipe a perforated water line was carried upon wood frames. Water was turned through the pipe and formed a series of sprays, keeping a cloud of moisture falling on the pipe. This sprinkling was carried on continuously day and night. In addition, during all daylight hours, a boy with a hose moved among the units and sprinkled all places not touched by the overhead spray. The spray holes in the overhead sprinkler were placed at 6-inch intervals. A water motor connected with the end of the pipe rotated the pipe back and forth in an arc upon roller bearings so as to disperse the spray more widely. The system was designed and pressure was regulated to allow curing of two or three rows of pipe from one overhead spray line.

Because of the condition of the bottom of the trench, a continuous concrete cradle was built under all the pipe, and upon the gravel or stone in which the underdrain was embedded. This cradle was in the form of a rectangular base section with a top curved concavely to take the curve of the pipe. The base was reinforced transversely but not longitudinally. No joints of any kind were used. Occasionally where quick-

THE PIPE CASTING YARD. CONCRETE WAS BUGGIED FROM MIXER TO ROWS OF FORMS. NOTE EFFECTIVENESS OF SPRAY SYSTEM OF CURING AND ARRANGEMENT OF OVERHEAD SPRAY LINE.

sand was encountered, longitudinal reinforcing was placed to give the cradle carrying strength over the bad spot. The mix for the base was set at 1-2-4, with the maximum size of the coarse aggregate 1¼ inch. Local sand subjected to ordinary tests for cleanness and durability was used for this part of the structure.

This cradle was laid well ahead of the pipe and was allowed to harden for at least 36 hours before the pipe units were placed on it. Two per cent of calcium chloride was added to hasten setting and hardening. The curve in the cradle was designed flatter than the curve of the pipe and it was at first intended to have the bottom of the pipe grouted ¼ inch off the base. It was soon found that ease and accuracy in laying to grade and line required greater lee-way than this, and the concave surface in the base was thereafter placed so as to allow ¾ inch of grout under the pipe. The radius of the curve was held at 36 inches. The grout was worked thoroughly under the sections by means of flexible steel blades 2 inches wide, ⅜ inch thick and 3 feet long, fitted with wooden handles.



CROSS SECTION OF MAIN CARRIER

In placing the units, each length of pipe was started into the bell of the preceding unit with crowbars and levers. The upstream end was then aligned and set to grade and held in position by wood wedges under the center of the bell end of each pipe and by wooden blocks between the sides of the pipe and the wood sheathing of the trench. A chain block fastened to a wood dead man which was wedged into pipe already laid and covered by backfill was then used to pull the unit into place. The design of the units was such that the bell and spigot were flush with the outside surface. The units were not completely pushed home, but were left ⅞ of an inch apart. The recess on the inside and outside of the pipe at the joint space was then filled with a stiff 1-1 mortar to which was added some hydrated lime to increase plasticity. This mortar was put in by hand. The joint was then painted on the outside with a special asphalt emulsion, designed to adhere to damp masonry and found, after extensive tests, to do so very satisfactorily; then a layer of asphalt-impregnated cloth, then another asphalt emulsion treatment, then another layer of cloth, then a final painting of emulsion. This type of joint proved unusually water-tight.

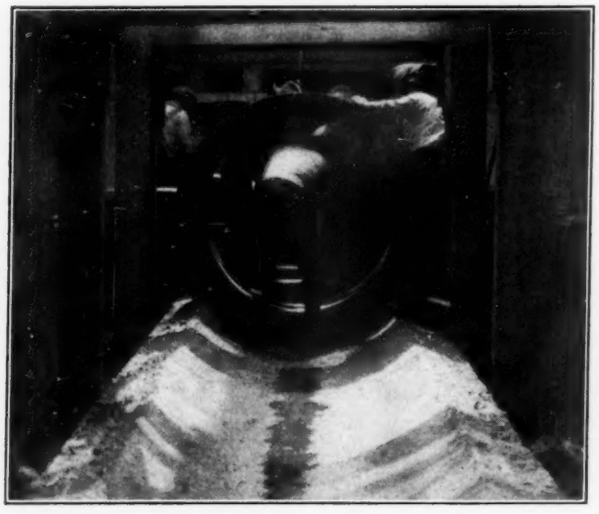
Before the sewer was begun, a new reinforced concrete arch bridge had been built at Freight street. Knowing that the sewer would soon thereafter be built, the abutment of the bridge was provided with an opening of the same cross section as the new sewer. This tunnel was connected up with the new pipe when work reached the bridge. This foresight proved a time and money saver.

At approximately 500-foot intervals, monolithic concrete manholes are installed in the new line. These manholes have rectangular chimneys opening three feet above normal low water and connecting at their lower end with a half section of pipe. The concrete is strongly reinforced to withstand ice and debris impact. The rectangular shape was selected so that a breaking edge might face upstream.

In some places there is very shallow cover over the pipe. In such positions a monolithic reinforced concrete mat is built over the pipe in the form of a flat double-pitched cap. This cap is 6 inches thick at the outer edges and 6 inches thick where it rests on the top of the pipe. In all cases a minimum of 18 inches of backfill over the pipe, or 12 inches over the cap, was specified.

After all backfilling had been completed on the first 4,600 feet of new sewer, pumping from the underdrains was stopped for sufficient time to permit the ground and river water to resume its normal level. An examination of the sewer revealed that, on clear days when condensation from the atmosphere did not interfere, ordinary matches could be struck and lighted on the interior surfaces of the pipe lengths.

About two-thirds of the pipe joints were entirely dry. The remainder were found to be damp, but only


LAYING PIPE IN CONCRETE CRADLE. THE SPACE BETWEEN PIPE AND CRADLE WAS GROUTED WITH CEMENT.

PLACING FORMS AND STEELWORK FOR MANHOLE. A PIPE UNIT WAS LEFT OUT OF THE LINE, THEN A LOWER HALF SECTION WAS CAST IN PLACE AND THE MANHOLE BUILT IN

in fifteen joints of the eleven hundred-odd in this portion of the sewer was water found actually trickling into the sewer. At these fifteen joints the mortar was cut out of the inside recess of the joint at and near the point where the seepage was found, and the recess caulked with lead wool. The lead filling was brought up to one-half inch from the inside pipe surface, and the rest of the recess filled with a 1-1 portland cement and sand mortar to cover the lead. Only two such joints had to be cut out a second time and re-caulked. After this had been done, no measurable leakage could be found. The amount of water collected after eighteen hours from behind a temporary cement and sand dam placed in the invert at the lower end of the 4,600 feet of sewer amounted to less than a gallon.

The city engineer for Waterbury, under whom this project is being carried out, is Mr. Robert A. Cairns. Design, location and construction work is in charge of Truman M. Curry, Jr., assistant engineer.

Dewatering Sludge With a Centrifuge

From experiments conducted at Baltimore, Keefer and Kratz concluded that sludge can be centrifuged to 71 per cent moisture at the rate of 42 gallons per minute per centrifuge, at the same cost as air drying

Experiments conducted at Baltimore, Md., in dewatering sewage sludge by means of a centrifuge were described by C. E. Keefer, engineer of sewage disposal, and Herman Kratz, Jr., junior chemist of Bureau of Sewage of Baltimore, in the January issue of "Sewage Works Journal." These experiments were begun in Baltimore in 1921 and additional tests with an improved type of centrifuge were made in 1924 and 1925. The authors state that centrifuges have been used in Germany for a number of years, but had been considered expensive to operate and had never been used in the United States except for demonstration purposes. One of the Schaefer-ter-Meer centrifuges was tested out in Milwaukee in 1920 and afterwards sent to Baltimore and used in a test there, beginning September, 1924. This centrifuge is named after Mr. Schaefer, who tried out at Cologne, about 1902, perhaps the first centrifuge machine used for sewage sludge. Later Dr. ter Meer cooperated with Mr. Schaefer in improving the machine.

Based on the Baltimore experiments, it was calculated that, to dewater the sludge of Baltimore, amounting to 91,700 cubic yards a year containing 91.82% moisture, the centrifuges working 8 hours a day for 300 days, would require six centrifuges each costing $18,000 installed, while sludge storage tanks would cost $8,600, cast-iron piping and valves $2,600, drain piping $800, belt conveyors $5,800, electrical wiring $4,100, and building $32,100; making a total of $162,000. It was estimated that the cost of labor would total $1500 a year for operator, $1320 for an oiler and $1080 for 300 days of labor at $3.50 a day; a total of $3900. In addition, the electric current, at 2¼c. per k.w.h., would cost $10,341; coal, oil, etc., $459; giving a total operating cost of $14,700, and a total cost, including interest on investment and depreciation, of $34,545. It was estimated that 25,910 cubic yards of 71% moisture cake would be produced, giving a total estimated cost of dewatering of $1.33 per cubic yard of cake. It was costing Baltimore $1.30 per cubic yard for air-drying sludge to 71% moisture, on drying beds costing $20,000 per acre, which was the cost of sludge beds recently built at Baltimore.

The authors reached the following conclusions from these experiments: That sludge similar to that at the Baltimore plant can be dewatered by a continuous, automatic centrifuge at a rate as high as 42.2 gallons per minute, giving a cake sufficiently dry to be handled easily. In a 28-day test, one machine dewatered an average of 11,800 gallons every eight hours with a total current consumption of 295 k.w.h., and removed 65.1% of dry solids and gave a cake with a moisture of 71.05%. While it is possible to air-dry sludge to 50% moisture, the moisture cannot be lowered below 65% by the centrifuge.

The average moisture content of the effluent from the centrifuge was 97.3% and the b.o.d. was 9100 parts per million. It was found possible to reduce the b.o.d. to 2815 p.p.m. by adding 0.28 ounce of alum per gallon of effluent. This, however, would increase the cost of dewatering about 10 to 12 cents per cubic yard.

Experiments with disposing of the effluent by adding it to untreated and to filtered sewage indicated that in the first case the b.o.d. of the untreated sewage would be increased 4.3% at Baltimore. Nothing was done to determine whether any of the colloidal material in the centrifuge effluent would be removed in a settling tank, or what effect, if any, this material would have upon the operation of trickling filters. In all probability such a study would have a direct bearing on the applicability of centrifuges at some sewage works. When one part of effluent was added to 1250 parts of sewage treated on trickling filters, the relative stability of the latter was reduced from 96 to 84. No information is available to indicate whether or not the diluted effluent would form sludge banks in the body of water into which it would flow.

In comparing the dewatering of sludge by air drying and by centrifuging, it is found that the moisture content of sludge dried on sand beds can be reducd considerably below that of the dried cake from centrifuges; but there should be no difficulty in handling the material when its moisture content is not over 70 to 72 per cent. The effluent from sludge beds can be disposed of more easily than that from centrifuges. At the Baltimore plant the effluent from the sand beds drains first through a layer of sand about 4 inches thick and then through graded gravel about 12 inches thick, and the effluent is clear and has an average b.o.d. of 365 parts per million.

Enumerating the advantages of using centrifuges, the authors state that sludge can be dewatered with centrifuges during unfavorable weather conditions and at all times of the year. Large quantities of sludge are not exposed to the atmosphere, and should the wet sludge be only partially digested, there would be practically no possibility of creating objectionable odors. A small amount of sand, which adheres to

the sludge, is removed when air-dried sludge is taken from drying beds, and its nitrogen content is therefore lowered somewhat and its fertilizing value is less. Where land is costly and only a small tract is available, a centrifuge installation has the added advantage of requiring only a small space.

New York Sewer Rental Law

A law permitting cities to assess rents for the use of sewers was passed in Ohio in 1923 and the successful operation of that law was described in PUBLIC WORKS for July, 1928. A somewhat similar law was introduced in the New York Legislature in January, 1929, under which both the general city law and the village law of that state are to be so modified as to permit cities and villages to assess and collect sewer rentals, the proceeds of which may be used only for maintenance, operation, and repair of the sewer system and sewage treatment works. Commenting on this law, Charles A. Holmquist, director of the State Department of Health, says: "We believe this proposed law permitting the establishment of sewer rents will serve to provide the necessary funds and be a decided help to cities and villages of this state in meeting the problem of operating sewerage systems, thereby reducing the amount of stream pollution."

Typhoid From Bathing in Polluted Water

The typhoid fever death rate in Connecticut for the year 1928 reached the lowest level ever recorded—0.6 per hundred thousand. The death rate was 3 per hundred thousand in 1922, 9 in 1914, and 22 in 1903. The morbidity rate in 1928 was 5.5, there having been a steady decrease from 32.4 in 1921. Litchfield County had the low morbidity rate of 1.2 last year.

In the monthly bulletin of the Connecticut State Department of Health for March there is a discussion of the subject, a part of which is devoted to consideration of typhoid in cities along the shore between New Haven and Greenwich, where there is a concentration of population and where sewage is discharged into some of the harbors with little or no treatment. Says the report: "In order to see whether the typhoid rates would indicate any possibility of bathing in polluted water causing higher typhoid rates along the shore, the rates for the combined cities and towns along our shore have been figured to compare with the rest of the state.

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	Av.
Shore communities...	35.0	25.8	27.2	30.5	26.5	22.7	14.4	11.2	5.9	6.4	20.0
Inland communities...	27.6	33.6	35.6	16.3	15.9	11.5	19.1	10.2	7.8	4.8	17.8

"It is thus seen that the rate for the shore communities is not significantly higher than the inland communities and the former rate would be considerably lower except for the inclusion of New Haven. Ciampolini and Hitchcock analyzed a series of 61 typhoid fever cases in the vicinity of New Haven in 1921 and 1922 and concluded that most of them were due to bathing in polluted water. Although this review has not included any study of the New Haven records, it seems fair to assume that without doubt bathing in polluted water may account for the fact that New Haven's typhoid rate leads that of all other large cities in the state. New Haven's harbor is highly polluted and receives the largest volume of untreated sewage of any harbor in the state. The city health department has rightly prohibited bathing in these polluted waters and the city is now going ahead with a program of sewage treatment. The quality of the public water supply and milk supply are certainly on a par with other cities. Except for the bathing hazard, the only other possibilities appear to be the consumption of shellfish taken from polluted areas by private individuals and the fact that an epidemic of considerable proportions nearly thirty years ago resulted in a larger number of typhoid carriers in the population than elsewhere in the state. Because of pollution, the entire harbor has been closed by the State Department of Health for market shellfish.

"Despite the proportionately higher incidence of typhoid fever in New Haven over other Connecticut cities, it should be borne in mind that the rate is extremely low as compared with other sections of the country, that the reduction in the past few years has been remarkable, and that as compared with other disease problems, this one has dwindled to insignificant proportions."

Water Softening at Columbus

We have described previously the process and plant used at Columbus, O., for recarbonation following the softening of the water supply. (See *Public Works* for June, 1927.) In his report for the year 1928, Charles P. Hoover, chemist in charge of the water softening and purification works, said that the recarbonation plant operated successfully during the entire year.

"For the past 19 years the alkalinity of the filtered water has averaged 55 p. p. m. During 1928, by the aid of recarbonation, it has been possible to reduce the average alkalinity of the filtered water to 43 p. p. m. For 19 years the average reduction of alkalinity has been 66%, as compared to 72% during the past year. The filtered water has, during the past 19 years, carried caustic alkalinity or excess lime to the extent of 5 p. p. m., whereas, with recarbonation, there has been no caustic alkalinity. Normal carbonates, which cause trouble due to formation of deposits on filter sand and in distribution pipes and meters, have been reduced to a figure which is well under the solubility limit.

"Trouble with filter sand, through which the entire water supply is filtered, due to the grains cementing themselves together and forming hard lumps has, we believe, been entirely eliminated. There has been great improvement in the operation of the condensors at the pumping station. In former years it required three days to clean a condensor. Now the job is easily done in one day. Further growth of deposits in the distribution system seems to have ceased. There has been a reduction in the number of meters clogged by carbonate deposits and the cleaning out of hot water coils has been reduced to a minimum."

During 1928 an average of 29.4 million gallons of water per day was softened, the hardness being reduced from an average of 242 parts per million to an average of 86—a reduction of 64 per cent. To effect this reduction required 2673 tons of soda-ash and 7991 tons of lime. The price paid for soda-ash

was $27.74 per ton, and the price paid for the lime was $6.52 per ton, making the total cost for soda-ash $74,149.02 and the total cost for lime $52,101.02. The cost of lime, soda-ash, alum and chlorine per one million gallons of water treated amounted to $13.67, or 49 cents per capita per year.

The cost of purifying and softening, on the basis of removal of one part of hardness from one million gallons, was 13.6 cents in 1928, which is 0.9 cent less than in 1927, and less than in any previous year. The total amount of hardness removed in 1928 was 2.19 times as great as in 1919, while the total cost was only 3 per cent greater. This is partly due to a reduction in cost of chemicals—lime, 36%; soda-ash, 32%; alum, 19%; and partly to the fact that the payroll expenditure was the same while the amount purified was 37½% greater.

There was a saving in cost of softening chemicals, estimated by Superintendent C. B. Hoover to be $76,350, due to storage in the two reservoirs; this estimate being made by computing the cost of softening the inflow water as it enters the upper reservoir, and comparing this cost with the actual cost of softening the water at the plant.

Decolorization by Storage

Karl R. Kennison, designing engineer with the Metropolitan District Water Supply Commission, Massachusetts, in a paper before the New England Water Works Association, described some data collected and studied by him with a view to learning the rate of decolorization by storage of water in reservoirs. In order to eliminate as far as possible other causes of decolorization, he stated, the reservoir should be clean bottomed, the color rather high to start with, and the reservoir large in relation to the natural inflow into the basin for the period during which the reduction in color is observed. In reservoirs without clean bottoms it is of course possible, if not probable, that additional color would be absorbed from the vegetable matter growing thereon, thereby offsetting to some extent the decolorization effected by the reservoir. He found two reservoirs meeting these conditions very well, one the Wachusett reservoir of the Metropolitan District, and the other Suntaug lake in the towns of Lynnfield and Peabody.

In the paper he gives tables and diagrams of analyses made during the years 1925 to 1928 inclusive. From these he draws the conclusions that the rate of color reduction, in the case of both Wachusett reservoir and Suntaug lake, approximated very closely to 20% every 30 days. In Suntaug lake the range of color ran from 75 to 9, while in the Wachusett reservoir it ran from about 22 to zero.

Dimethyl-P-Phenylenediaminechlorinehydrate

As the use of chlorine for sterilizing drinking water became general, chemists adopted the use of orthotolidin as a test for the presence of minute quantities of residual chlorine in treated water—and, incidentally, water works engineers learned to pronounce the name. Will they ever be equally successful with the above alphabetical potpourri, we wonder. This multisyllabic congeries of heterogeneous alphabetical symbols is the name of a substance (called familiarly by chemists $NH_2.C_6H_4.N.(CH_3)_2HCl$) proposed as a substitute for ortho-tolidin by Knut Alfthan, chief chemist of the city waterworks of Helsingfors, Finland, who says that after using it for nearly a year he finds several features of superiority to other indicators.

A brief article describing its advantages may be found in the September, 1928, Journal of the American Water Works Association.

Alum Treatment at New Rochelle

The system of the New Rochelle (N. Y.) Water Supply Company includes four reservoirs, each with a small water shed. No. 1, the highest of them, supplies the low-service distribution system of this company by gravity; No. 4 is used for storage only and the water from it is pumped into No. 1; while No. 3 feeds by gravity into No. 2, in which is located the pump intake for the high-service distribution system, the water from No. 3 flowing into No. 2 through a concrete flume and then through 300 feet of 36-inch pipe.

The water in No. 2 has a color varying from 5 to 35, turbidity of 10, hardness of 58, and alkalinity of 42. On account of the high turbidity and color, it was decided to adopt some treatment, and an alum treatment plant was installed in the flume immediately ahead of the 36-inch line. At this point there is a basket formed of wooden slats, square in section and 36 inches across the top and 18 inches at the bottom, the basket being about 36 inches deep. In this the alum is placed. This basket is suspended in a box 48 inches square and 48 inches deep, which in turn is suspended in the water just before it enters the pipe. A 2-inch pipe in the up-stream side of the containing box allows water to enter the alum basket, while two 2-inch pipes on the opposite side afford an outlet for the water. The water flows through this line from one reservoir to the other at the rate of about 3 million gallons per day, the rate at which it is pumped into the distribution system, and this gives a good velocity in the pipe, which serves to mix the alum solution from the basket with the remaining water. At the outlet of the pipe line are rocks and stones which afford partial aeration.

A very good floc is obtained and the turbidity is reduced about 50% and the color about 70% at times of high color. On August 29 of last year the color was 35 parts per million at reservoir No. 3, which was reduced to 10 parts per million at the pump intake in reservoir No. 2, about 3,000 feet away; while the turbidity was reduced from 11 p.p.m. at the upper reservoir to 5 at the pump intake.

Stopping Landslide at Syracuse

The city of Syracuse, New York, in 1927 widened and relocated the pavement on East Genesee street between the new and old city lines, which necessitated cutting deeply into a hill just east of the old city line. "Soon after the pavement had been completed it was noticed that a section of it along the cut was beginning to heave, and that the higher sections of the bank were breaking away and falling down onto the pavement. Several thousand yards of additional excavation was made at this point, which relieved the situation temporarily, but during the winter of 1927-28 the heaving of the pavement and of the tracks

of the Syracuse and Eastern Railway Company began again and assumed serious proportions.

"Investigation by drilling disclosed the fact that the bank was composed of a top layer of pervious clay resting on a layer of impervious material. When this top layer became saturated with water from rains and numerous springs, it slid along the top of the impervious stratum until it reached the edge of the pavement, where it started to rise and cause the pavement to heave."

In order to remedy this condition, steel sheet piling was driven to a depth of about 30 feet just north of the railroad tracks which lie at the foot of the bank, between that and the road paving. This piling was surmounted by a concrete retaining wall. Another row of steel sheet piling was driven about half way up the hill. Trenches were excavated immediately behind each row of sheet piling and filled with crushed stone and were connected with the sewer on Genesee Street by means of a vitrified pipe. Also a portion of the saturated soil was removed and replaced with gravel fill.

Nelson F. Pitts, Jr., city engineer, in his annual report presented at the beginning of 1929 stated that the results to date indicate the effectiveness of the corrective measures. The work of improving the slide was carried on during the summer of 1928. As soon as weather permits in 1929 it was intended to let a contract for grading the slope of the hill in such a way as to increase the stability of the bank, the contract including sodding and landscaping. The cost of the work done in 1928 was $28,700.

Refuse in Greater New York

Amounts of different kinds collected, with monthly variations. Estimated cost and income from incineration

"Physical Conditions and Public Services" is the title of Volume VIII of the regional survey being made by the Regional Plan of New York and Its Environs, which has just been published. This is, we believe, the most comprehensive survey that has ever been made of an area of this size. This volume embraces studies of geography and soil, climate, water supply, sewage disposal, refuse disposal, and oil pollution of the harbor waters; also power, heat, and light, and the supply and distribution of commodities; distribution of hospitals in and about New York City and the present and future prisons of the city.

The discussion of geography, soil and climate, are of chief interest locally. Most of the information given concerning water supply and sewage treatment has already been given from time to time in PUBLIC WORKS. Concerning the disposal of New York's refuse we have published considerable matter but some figures are given in connection with the stating of the problem which we believe will be of interest to officials of other cities and other students of the problem.

The latest figures given in the report are those for the year 1925. During this year there were collected in the Borough of Manhattan 2,877,000 cubic yards of ashes, 791,000 of garbage, and 2,587,000 of rubbish. In the Borough of Brooklyn, 2,329,000 cubic yards of ashes, 656,000 cubic yards of garbage, and 2,474,000 cubic yards of rubbish. In the Borough of the Bronx there were collected 725,000 of ashes, 365,500 of garbage and 560,000 of rubbish. Figures are given for each year since 1905, and these show that the amount increased enormously in all three boroughs during the five years following 1920—about 20% in Manhattan, 40% in Brooklyn, and more than 100% in the Bronx.

Taking the totals of the five boroughs in 1925, we find that garbage constituted 14% by volume and 21% by weight, ashes 44% by volume and 70% by weight, and rubbish 42% by volume and 9% by weight. (These are calculated on the basis of an average weight of ashes and garbage of 1100 pounds per cubic yard and rubbish 150 pounds per cubic yard.) Of the total refuse, 26.2% was incinerated, 19.7% was dumped in sea, 24.8% was dumped at Rikers Island and 29.3% dumped on land in the various boroughs. About a third of the refuse from the Borough of Manhattan was dumped at sea and about 9% was incinerated, the remainder, or a little over half, being dumped at Rikers Island, except for about 3% which was dumped on Manhattan Island itself.

In addition to this, there were collections by private collectors of ashes and garbage and possibly of some rubbish. Probably 80% or more of the steam boiler ashes and cinders are collected privately and used for concrete and other purposes. The privately collected material must run into large yardage, since it includes all of the waste from industrial plants, department stores and hotels. This, however, removes from the figures of the department the garbage due largely to the many thousand visitors not included in the population, while the other refuse is not domestic refuse; consequently the figures given above would more nearly approximate those from the ordinary city where there is a much smaller visiting or floating population and a relatively smaller amount of manufacturing and other industries.

A table of the monthly variation of refuse collected in 1925 shows that, in the case of ashes, the maximum was reached in February, being 11.4% of the entire year, decreasing to 8.8% in April and to 6.2% in June, from which it fell but slightly, rising to 7.8% again in October. Garbage reached its maximum of 11.2% for both August and September, the minimum being 4.6% in January. Rubbish reached a maximum of 9.5% in October and a minimum of 5.8% in January, the variation therefore being much less than in the case of ashes and garbage.

A table of the different classes of refuse calculated in pounds per capita per annum for the year 1925 shows that there were collected in Manhattan 1457 pounds of ashes, 401 of garbage, and 179 of rubbish; in Brooklyn 1163 pounds of ashes, 327 of garbage and 168 of rubbish; and in the Bronx, 916 pounds of ashes, 461 of garbage, and 96 of rubbish. The smaller amount of ashes and rubbish in the Bronx may be explained by the fact that this part of the city is not yet as thickly settled as Manhattan and Brooklyn and there is more opportunity for using this material for fills, for burning on vacant land, etc. Comparing these figures with

corresponding ones for the year 1905 shows that in Manhattan the per capita amount of ashes has increased slightly, that of garbage has nearly doubled, and rubbish increased about 70%. In Brooklyn, the amount of ashes has more than doubled, garbage increased 2¼ times and rubbish 4 times. In the Bronx, the per capita ashes increased about 30%, garbage nearly 4 times, and rubbish nearly 5. Combining ashes, garbage and rubbish, we find the total refuse increased at the rate of 38% in Manhattan, 127% in Brooklyn and 58% in the Bronx.

The cost to New York City of dumping garbage at sea after loading at the waterfront dumps was about 15c per cubic yard in 1924. Four hundred and ninety-four tows were handled that year, and the dumping ground was about 42 miles from the Battery during the summer months and several miles nearer during the winter.

An estimate is given of the cost and income from incineration in New York. "A modern high temperature destructor will furnish sufficient heat for the evaporation of one to two pounds of water per pound of refuse burned, depending upon the composition of materials, in addition to any pre-heating of air required for the furnace operation. One ton of mixed garbage and rubbish per hour should generate 1750 pounds steam or about 50 boiler horse power. Assuming generator efficiency of 87%, the developed horse power would be 44.5 per hour or 33.2 kilowatts per hour. For a 200-ton plant on a yearly basis this would be 50,000 tons × 33.2 = 1,660,000 k.w.h.

"Electricity could be sold at approximately one cent per k.w.h. or $16,600 per annum. If the electricity could be utilized for lighting and general purposes in New York City municipal buildings, it would save a present expense of 5.40c per k.w.h. or $89,500.

"The first basis, i. e., incineration without production of steam, would give an estimated 1925 unit cost of incineration of $2.36 per ton of garbage and rubbish. With production of steam on the basis outlined above, the unit cost of incineration would be 0.57c per ton of garbage and refuse.

"Itemized costs have been computed based on labor charges obtained for certain incineration plants in New York City for 1925. For a 150-ton plant handling 110 tons of refuse per day, the following labor was required.

One stationary engineer at $8.50 per day	$8.50
Six firemen at $6.50 per day	39.00
Three garbage stokers at $5.50 per day	16.50
Two ash pickers at $5.00 per day	10.00
Two watchmen at $5.00 per day	10.00
Total labor cost of disposal of 110 tons of refuse	84.00
Labor cost of disposal per ton of refuse	.76

"Similar figures for a 100-ton plant, handling 75 tons of refuse, showed a labor cost of 74c per ton of refuse. Taking into consideration all items of operation and maintenance, the following approximate subdivision of cost per ton was obtained.

Labor	76c
Other maintenance and operation costs	6c
Interest on investment at 6%	60c
Amortization	24c
Depreciation	24c
Total cost per ton	$1.90

"The refuse problem was one of those studied by the Subcommittee on Sanitation and Harbor Pollution of the New York City Committee on Plan and Survey. Their report referred to the dumping of garbage at sea as a temporary expedient which should no longer be tolerated, and contained the following recommendations. (1) That all garbage and rubbish collected in the City of New York should be disposed of through incineration, as this system appears to be the one best suited to the needs of the city.

"(2) That a number of incinerators be erected, each plant to take care of the refuse collected in a specified zone, rather than a central plant for disposal of the refuse of the entire city, and that the boundary lines of the zones be set up by the commissioner of street cleaning for the Boroughs of Manhattan, Bronx, and Brooklyn, and by the respective borough presidents of Queens and Richmond.

"(3) That consideration be given to the installation of a special incinerator for the destruction of carcasses of dead animals, to be operated under the jurisdiction of the Commisioner of Street Cleaning.

"(4) That the program as outlined be pushed with all possible speed, so that the city may soon be equipped with an adequate refuse disposal system for all classes of waste, obviating the necessity for sending refuse to be dumped at sea and removing all cause for complaint of littered beaches so far as the city of New York is concerned."

These recommendations are supported by the Regional Plan Commission and the following general conclusions reached: "(a) The practice of dumping garbage and refuge at sea is both wasteful and insanitary. (b) Engineering methods for disposing of refuse by incineration or reduction have been developed to a point to enable these methods to be employed efficiently and without nuisance if plants are properly designed and operated. (c) The various communities in the region should provide and set aside suitable sites for garbage treatment plants. (d) Closed containers for the transportation of garbage through the city streets would do much to avoid objectionable and unhealthful conditions. (e) The cost of providing suitable garbage treatment plants is not so great as to offer serious financial difficulties. (f) Scientific methods of refuse disposal should result in considerable financial savings and in some cases may return a profit."

Jacking Drain Under Highway

In constructing a short storm drain in September, 1928, the city of Green Bay, Wisconsin, utilized the jacking method in carrying it under an 18-foot pavement of state highway #41. The drain, after passing under the highway, extended straight for 150 feet, turned diagonally under a side street and turned again to an outlet. The total length was about 250 feet, and 42-inch Armco corrugated pipe was used.

The trench was dug and pipe laid from the outlet up, the pipe being delivered in 10-foot and 20-foot sections, rolled into the ditch and joined with coupling bands; backfill being placed as soon as the pipe had been laid. The pipe was laid in trench to a point 31 feet from the edge of the pavement, thus leaving room for the 20-foot section of pipe which it was intended to jack under the pavement and also for the jacking layout. A short length of trench was dug also on the other side of the pavement at the point where the jacked pipe was expected to emerge.

Between the pipe already installed and the edge of the pavement, in the ditch dug there, mud sills were placed in the bottom of the trench and on these two 6x6 parallel lining timbers 22 feet long were anchored securely in such positions as to support the pipe exactly at line and grade during jacking. For a backstop, cross ties were placed against the end of the pipe already installed. A bearing frame of 4 by 8-inch timbers was built and placed against the end of the length to be jacked and a 25-ton track jack was placed between the backstop and the pipe. Pressure was applied by the jack and a laborer inside the pipe began excavating material for one or two feet ahead, making an opening which left a neat clearance for the pipe. The soil was a damp clay which was ideal for jacking as it arched readily and was comparatively easy to remove. The position and size of the excavated opening were checked carefully after each two feet of progress. This careful checking contributed much to the ease of the jacking operation.

The jacking operation occupied about 15 hours, with only three men employed, and cost $1.55 a foot for the 19 feet through which the pipe was jacked. This method of construction avoided the cutting of the highway and thus interfering with traffic, and also the construction and future maintenance of the cut which would otherwise have been made in the pavement. F. J. Steeno was city engineer of Green Bay when the work was done. Ed Knaus, sub-contractor, was in active charge of the work.

Draglines and Industrial Rwys. on Levee Work

In every levee job, the contractor has to figure on fighting the weather and the river as well as ground conditions, which combine to delay the work; and in addition, each section presents its own peculiar construction problems. Until recently, the levee contractor has retained the faithful mule, and "with hundreds of miles of him on the river", (as expressed by one of the pioneers in levee building), has completed many miles of levee with a moderate amount of efficiency. But such methods, while well suited to the small contracts in the past, can not be used economically for large contracts and the radically changed sections and grades. Then, too, the magnitude of the work in prospect has attracted many contractors to this field, who have brought to the problems new thoughts and new ideas. In this article are described the methods being employed on one of the largest single contracts along the river.

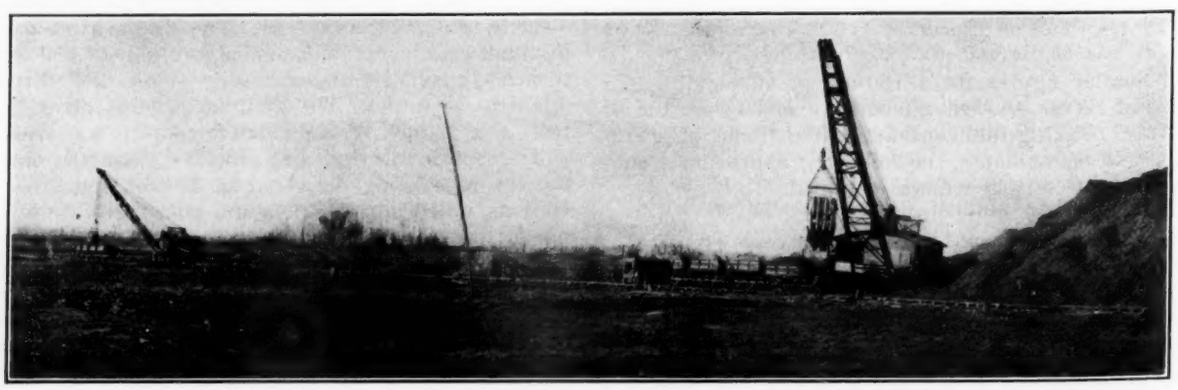
By J. C. French*

The Canal Construction Co., of Chicago, Ill., and Memphis, Tenn., with considerable experience in drainage and irrigation work, secured a contract in the Upper Yazoo Levee District near Lake Cormorant, Mississippi, involving 1,900,000 cubic yards of levee construction, of which 1,250,000 yards was for new loop construction and 650,000 yards for enlargement. This company has also taken on work near Lake View, Mississippi, in the same levee district, of about 600,000 cubic yards, making the total work alloted to it about 2,500,000 cubic yards.

The members of this organization gave serious consideration to the problems involved in handling these contracts, including soil and weather conditions and the time limit imposed by the government, as well as cost, and they decided upon a radical departure from old time methods, involving the use of drag lines and industrial railway equipment working in combination. The plant is divided into a number of units, practically identical, placed at intervals of about a half mile, offering an opportunity to incite the crews to compete as to which shall place the most yardage in a day. The general plan of operation of each unit is as follows:

Each unit consists of two Monighan draglines—a 3-yard machine with a 75-foot boom located at the levee end of construction, and a 2-yard machine with a 60-foot boom placed at the borrow pit end; while between them runs an industrial railway of 36-inch

*With the Monighan Mfg. Corporation.



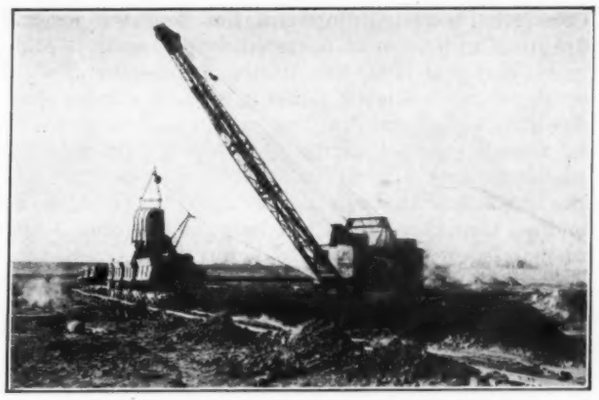
ONE UNIT—THREE-YARD DRAGLINE AT LEVEE AT RIGHT, TWO-YARD DRAGLINE LOADING TRAIN AT LEFT, AND INDUSTRIAL TRACK CONNECTING THE TWO

gauge with the track extending from a point beyond the land side toe of the levee to a point at the extreme outside limit of the borrow pit. Maximum efficiency, of course, consists in so conducting the work as to keep each of these operating at maximum efficiency.

The industrial railway equipment consists of 5-yard "Western" cars, which are handled in trains of four cars each, there being two trains to each unit, each pulled by a 6-ton Vulcan gasoline locomotive. Only a single track is used, with no switches or detachable joints. The ties are carefully selected and a track crew inspects the ballasting frequently to insure proper traction.

In beginning operation, a pit is dug between the industrial track and the levee section being built, at a point within a few feet of the track and parallel to the levee section, which is used to hold the material that is discharged from the dump cars until the 3-yard dragline can dig it out and transfer it into the levee proper; a pit being used so that the cars can be dumped below the track level and also so that the dragline bucket of the 3-yard machine can be loaded in its natural manner. This is called a transfer ditch, and is built by the 3-yard dragline. It is given approximate dimensions of 11 feet wide and 7 feet deep. It is made long enough to receive the material dumped from the four-car train. As the work progresses, the pit is gradually filled up at the rear end and extended forward. When a section has been completed, the 3-yard dragline moves ahead 60 feet, moving the track within its reach the same distance at the same time; while the balance of the track is moved ahead by a small caterpillar tractor. The track is never disjointed, but is moved along bodily, being skidded into position rather than moved by a direct lift.

After the industrial railway track has been placed in its new location, the 2-yard dragline moves across the end of the borrow pit parallel to the levee, into position for starting a new cut. This dragline is used for loading the cars, and while excavating the borrow pit and loading, it moves back and forth at right angles



TWO-YARD DRAGLINE LOADING DUMP CARS

to the levee from one end of the borrow pit to the other.

While one train of 5-yard dump cars are being loaded the other train is being pulled towards the levee and transfer pit. It is dumped into the pit and then pulled beyond it so that the second train can be pulled into position at the transfer pit for dumping; following which both empty trains are pulled back into loading position together. This system requires five minutes for loading the two trains and a six-minute shut down of the loading machine while the trains are being pulled to the transfer pit, dumped and returned. The capacity by this method averages 30 yards per 11-minute cycle, or 1800 yards per 11 hour shift. As high as 140 trains have been loaded and emptied in one 11-hour shift. The cost by this system is believed to be less than by any other employing transportation over the ground, and the operation can be continued throughout the rainy season. It is continuing operation at the present time, during the most difficult season of the year—flood stages of the river and the rainy season.

The contractors have under way at the present time an improvement over the system described, introducing what is called a "ring-around" track system. This provides an endless track connection be-

DRAGLINE LOADING CARS AT RIVER-SIDE EDGE OF BORROW PIT. EXCAVATED BORROW PIT IN FOREGROUND. MISSISSIPPI RIVER AND OLD LEVEE IN BACKGROUND.

tween the levee-building dragline and the loading dragline, which can be operated so as largely to eliminate major delays and insure a constant flow of yardage into the levee. Also it permits a more effective location of the dragline, which can then operate in a path parallel to the levee proper, rather backward and forward at right angles to it, as in the precedure described. The track is laid in an endless loop about 1000 feet long, and a levee section of that length can be placed before it is necessary to relay the track in another loop. The changing from one loop to the other is by progressive stages, the first loop being broken and the second one placed in commission in track sections, rather than by a complete new loop. While a new loop is being built, the old straight-away track system would be used. The transfer pit is dug parallel to the levee and becomes a continuous proposition, with one end being dug continually while the other is being filled up.

Not only do conditions on present and future contracts differ from those on former work because of their magnitude, but the present contracts differ among themselves. In the upper river districts, especially north of Vicksburg, difficulty is presented by the long hauls necessary to convey the required amount of yardage from borrow pit to levee, caused by the shallowness of the borrow pits, the slope being limited to 50 to 1.

Levee Construction in the New Orleans River District

The New Orleans River District of the Mississippi River Commission extends from Warrenton, Miss., to Head of Passes, a distance of 458 miles. The average present height of levees is 18 feet, but this will be increased to 21 feet by the completion of the present adopted plan of flood control. The section of the levee differs from that used in other districts in that there is no banquette, and a borrow pit slope on the river side of 1 on 10 is permitted. This feature, by providing a considerable additional amount of dirt within reasonably easy reach of the center line of the levee, eliminates many of the difficulties already considered in previous articles. As a result, prices are lower. Draglines are now the commonly accepted method of levee construction in this district, and, with very few exceptions, this is the only type of machine now being used.

LEVEE SECTIONS

The present adopted levee sections are as follows:

Class A (75% or more "buckshot")—Crown, 10 feet; river-side slope 1 on 3; land-side slope to contain seepage line of 1 on 6 springing from the point of assumed maximum flow on the river-side slope.

Class B (loam)—Crown, 10 feet; river-side slope 1 on 3½; land-slide slope to contain seepage line of 1 on 6½ as above.

Class C (75% or more sand)—Crown, 12 feet; river-side slope 1 on 5; land-side slope to contain seepage line of 1 on 8, as above.

From the toe of the river slope is a 20-foot berm, following which is a 1 on 2 slope to a depth of 3 feet, and thereafter 1 on 10. Practically all the levee sections in the New Orleans River District fall under the "B" classification.

Work in this district involves either enlargement or setback work. Much of the levee is still considerably below standard grade and much weaker than the standard section. Topping still in place on these levees is a reminder of the desperate and long continued fight of April, 1927.

The rate of bank erosion, where there is such erosion, is pretty accurately known, and appears to be fairly uniform in most cases. Setbacks, based on this knowledge, are being planned on a 30-year basis, as a rule. Thus, where the rate of erosion of the bank is 10 feet per year, levees are set back about 300 feet. The river is apparently more stabilized in the lower New Orleans district—from Baton Rouge south—than on the upper river.

CONSTRUCTION WORK

Weather and river conditions generally have been favorable, and most of the work has been going on at a good rate.

At Reserve, La., (on the left bank) about 15 miles above New Orleans, is a levee setback job involving about 165,000 cubic yards of earthwork. This contract was awarded to O. O. Ogden, Baton Rouge, La., at 14.23 cents per yard and was sublet to Adma and Gavolet of New Orleans and Pt. La Hache. On this section, the levee is being set back 110 feet, and it is possible to use the old levee for making the new one. The only machine on the job is a Marion steam excavator, Model 262, of the track type. It has a 125-foot boom and uses a 4-yard bucket. This machine completes the levee section in two jobs. The first trip takes part of the old levee and throws up the land side of the new levee. It then goes back, traveling nearer the river, and completes the job, using the remainder of the old levee and material from the borrow pit. The levee is brought to the proper slope by a gang with shovels, assisted where possible by the dragline operator.

This machine, working on two 10-hour shifts, has been handling 60,000 to 65,000 cubic yards of pay dirt per month. A. H. Lefebur is inspector in this job.

Just up the river, at Hope, the Lower Coast Construction Co., Ltd., has a contract for a setback levee involving 295,000 cubic yards at 19.68 cents per yard. This company has two machines now on the job, both throwing up a spoil bank preparatory to starting the levee section. On this work three trips will be necessary, and some of the dirt will be handled twice. One machine is a Bucyrus dragline, skid and roller, with a 115-foot boom and a 3½-yard bucket, and the other is a Monighan, with a 100-foot boom and a 2½-yard bucket.

The Lewis-Chambers Construction Co., Inc., New Orleans, La., has a set-back job at St. Elmo, involving 290,000 cubic yards at 17.96 cents. On this job is a

Bucyrus-Erie, Class 230, dragline, with a 165-foot boom (center to tip) and a 6-yard Bucyrus bucket. This machine has proved most efficient, and a similar one is in process of construction for another job which the Lewis-Chambers Co. has farther up the river. Operating on two 10-hour shifts, this machine has been handling dirt at the rate of 125,000 cubic yards of pay dirt (165,000 cubic yards of unsettled levee) per month. On the first trip it throws up the land-side slope, and on the second trip throws up the river side and dresses the land side. Final dressing is by hand, aided by dragging the bucket over the rougher places.

A government job is under way at Gay. This involves 408,000 cubic yards on which the government bid was 18 cents. This is setback work, and two Bucyrus draglines, each with a 125-foot boom and 4-yard bucket, are operating on the work. Machine U. S. B 5, J. E. Roberts, overseer, is placing levee, while U. S. B 2, H. R. Boudreaux, overseer, is throwing spoil bank. At Willow Grove, the Lewis-Chambers Construction Co., Inc., is preparing to start a contract involving 520,000 cubic yards at 21.5 cents, using a duplicate of its machine at St. Elmo. This company also has a job at Margaret, totalling 580,000 cubic yards at 21.9 cents and is working a Bucyrus dragline.

At Eliza is another government job, which calls for 325,000 cubic yards of setback work. The government bid on this was 19.7 cents. U. S. B 3, a Bucyrus Model 190 with a 4-yard bucket and 125-foot boom, is throwing up spoil bank, but a considerable portion of the levee has been completed. E. A. Burriss is overseer of this job.

Dameron & Kenyon have a setback job at Alford, on the right bank of the river, which totals 310,000 cubic yards. On the job are two Monighan and two Bucyrus draglines with 100- to 125-foot booms and 3- to 4-yard buckets. On this job there are also fifteen 4-mule teams working from an elevating grader. The draglines are working so as to finish the levee with one trip each. Thus one machine throws the first spoil bank; the second machine throws a second spoil bank, while the third machine completes the levee section.

At Lakeland, on the right bank of the river above Baton Rouge, are two hydraulic jobs amounting to 330,000 and 326,000 cubic yards respectively. These were awarded to the McWilliams Dredging Co., which is operating a standard type of river dredge on the

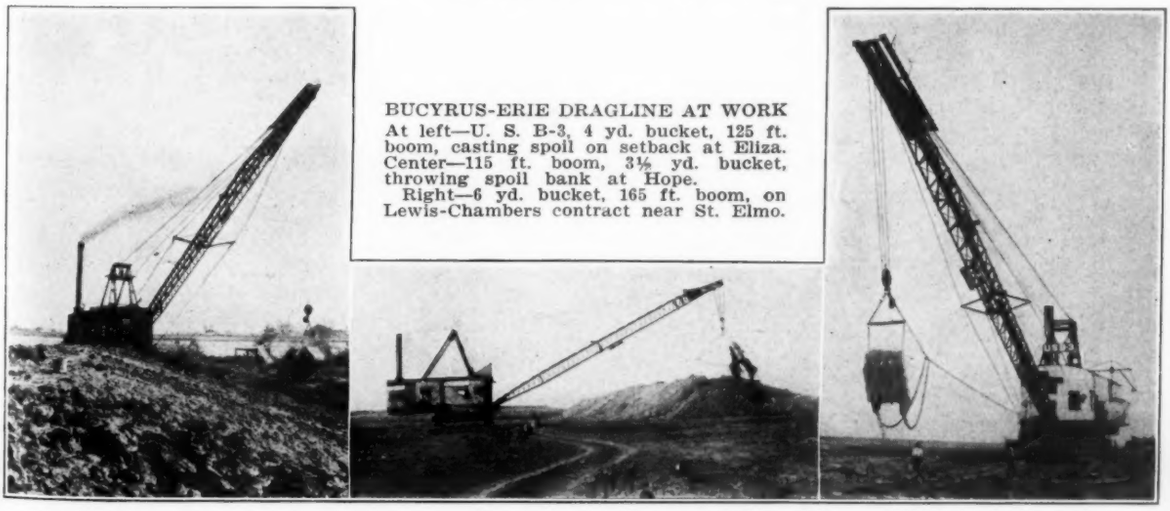
MARION STEAM EXCAVATOR, 4-YD. BUCKET, 125-FT. BOOM, ON LEVEE SET-BACK CONSTRUCTION.

work, which consists of filling behind the levees to provide a blanket to prevent sand boils, which developed to a dangerous extent during the 1927 flood. This blanket is 7 feet thick at the levee. An earth dike to contain the hydraulic fill was thrown up by a small dragline, with a 40-foot boom.

Other jobs in this area from just above Baton Rouge to New Orleans include the government contract at St. Francis Church, involving 338,000 cubic yards of levee at 21.5 cents. One Bucyrus dragline (U. S. B-6) with a 4-yard bucket and a 125-foot boom is operating on the job. At New Tensas, there is a government contract covering 750,000 cubic yards at 19.85 cents, on which the United States Machine B-10 is working. Ferdinand LeBlanc is overseer on this job, and Frederick Zuber is in charge of the St. Francis work.

The New Orleans River District is in charge of Major W. H. Holcombe, district engineer. Most of the work above described is in the Third area, which stretches from Old River, Angola, La., to the upper limits of New Orleans Harbor. The acting area chief is associate engineer F. C. Carey, who is assisted by W. B. Kirby, associate engineer, and Ferdinand Estopinal, Jr., inspector.

Work on the proposed Bonnet Carre spillway has consisted chiefly of a study of hydraulic features and surveys and cost estimates for flowage. A model of the spillway on a small scale, having a crest width of 3.33 feet, is now nearly ready for testing. This was planned by assistant engineer Howard E. Boath, in conjunction with Prof. W. B. Gregory, consulting engineer. Water for testing will be pumped from the river by a dredge. The work at Bonnet Carre has been under the direction of Captain Helmer Swenholt, but Major E. S. J. Irvine recently has been detailed for temporary duty in connection with the work.



BUCYRUS-ERIE DRAGLINE AT WORK

At left—U. S. B-3, 4 yd. bucket, 125 ft. boom, casting spoil on setback at Eliza. Center—115 ft. boom, 3½ yd. bucket, throwing spoil bank at Hope. Right—6 yd. bucket, 165 ft. boom, on Lewis-Chambers contract near St. Elmo.

Highway Lighting in Michigan

The De Quindre road, north of the 17-mile road around the city of Detroit, has been lighted for six miles of its length by means of 600-candlepower incandescent lamps mounted 300 feet apart and 30 feet high, this being the standard practice of the Detroit Edison Company, which has so far installed more than 375 miles of highway lights. Because of local laws, it was not possible to install pole lines close enough to the edge of the paved surface to employ efficiently the bracket or mastarm fixtures, and it was therefore necessary to employ the center-span type of construction, mounting the unit over the center of the roadway, which required an extra pole for each light opposite the pole line carrying the lighting circuit.

Series circuits were employed, using I L transformers for each unit, as these were found to be the most economical type of construction. The height of 30 feet was found to be the minimum required, so long as the lights were hung over the center of the roadway, if possibility of glare was to be eliminated. But at this height the effective light on the roadway is reduced and part of it is wasted on the ditches and sides of the road. To concentrate the greatest amount of light possible up and down the roadway and downward toward the road surface, it was found desirable to mount fixtures equipped with two-way bowl refractors. These were glaring when so set that the maximum beam of light was up and down the center of the road, but this was overcome by turning the refractors a few degrees toward the edge of the road in the direction of traffic.

Tower wagons were not available for servicing these units. A cutout type of fixture was desirable, but the design previously used for arc lamps was not satisfactory, since the circuits from the pole line to the fixture were lowered with the fixture. Such an installation was unsightly and had high maintenance because of the circuits swinging in the wind and breaking off. Furthermore, such devices would not orient the fixture when it was returned to its operating position and it was therefore necessary to design a new device. That adopted consists of a combination orienting pulley and cutout, together with a new center span unit. Means are provided for clamping this combination rigidly to the span wire. The secondary circuit is connected directly to the cutout part of the fixture, which is fastened rigidly to the span wire. To lower the fixture, the rope to which the orienting device is fastened is pulled tight, thus unlatching and disconnecting the fixture and permitting it to be lowered to the ground for servicing. When the fixture is pulled back into place, the orienting device swings it into proper position for correct light distribution and the latch holds it in place; connections between the fixture and the circuit being made at the same time.

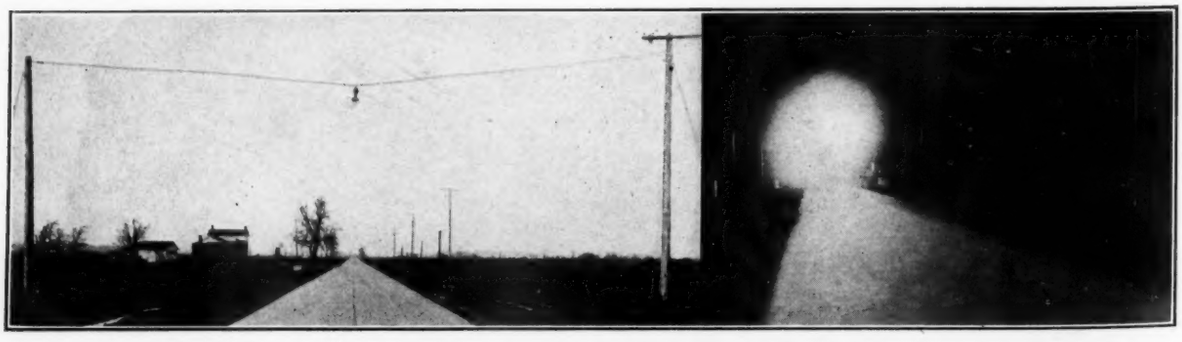
Shell Roads in Texas

In south Texas, lying along the Gulf of Mexico, the coast is a plain and the soil ranges from sandy loam to heavy black earth. During the long rainy spells which are common during the winter months, this low-lying black land turns to impassable muck, which makes highway travel impossible except on horseback. For that reason, improved highways of some sort have always been a necessity.

Until recently however, nothing but oyster and other shells dredged from the gulf and the bays along the shore were used for improving the roads. The shell roads were fairly satisfactory for light traffic but quickly wore into holes under that of heavy trucks. Also, the black soil seemed to work up through the shells or the shell be pushed down into the muck, so that frequent additions of shell were necessary. Recently, in preparing for a concrete pavement on one of these highways, the old shell roads were excavated and shell was found to a depth of 3 or 4 feet, although the surface was as muddy as though no surfacing had ever been applied. Shell roads have played a very important part in the development of that section of the state, but the time is fast approaching when, all through that country, something more durable and substantial will be necessary to carry modern heavy traffic.

Delhi Uses Ozone to Disinfect Water

The water supply authorities of the village of Delhi, N. Y., have recently constructed and put into operation a modern water purification plant costing about $42,000 as a result of recommendations of the New York State Division of Sanitation. The plant is of the pressure rapid sand type with coagulation basin and chemical feed equipment. The effluent is disinfected by ozone. The filtration equipment is of the ordinary type, but the employment of ozone for the disinfection of a public water supply is unusual in this country, although fairly common in some of the larger cities in Europe. The ozone installation at Delhi is the first in New York State to be used for disinfection of a public water supply and as far as is known it is the second in the United States.—*N. Y. State Health News.*



HIGHWAY LIGHTING OF DE QUINDRE ROAD, TROY TOWNSHIP, MICHIGAN. DAY AND NIGHT VIEWS

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County Highway Work in 1929

Many prognostications have been made of the probable amount of work of different kinds—building construction, public works, etc.—that will be done this year as compared with that accomplished in 1928, and they seem to agree quite generally that the amount will be about the same. The questionnaires sent by us last month to county highway officials asked them to report the mileage of different kinds of road improvement performed in 1928, and to estimate that expected to be done in 1929; and a comparison of these figures should furnish a very sizable straw indicating which way the 1929 wind is blowing.

A considerable percentage of the officials did not answer the question as to 1929 work, most of them probably because decision as to this year's work had not yet been made. Most of those that did reply gave uneven figures indicating that the quantity was not a mere guess, and only thirteen gave figures the same as last year. It would appear, therefore, that the comparison would be reasonably reliable.

At the time of tabulating and comparing these reports, 138 of the questionnaires that had been received from all sections of the country, gave apparently reliable and comparably replies to both questions. These reported that 6,058 miles of road surfacing and paving were done in 1928 and 5,878 miles would be done this year—a difference of less than three percent. This comparison, therefore, gives a conclusion similar to those made with reference to other lines of work.

Examining the figures, we find, as stated above, that thirteen expect to do the same amount of work this year as last; that seventy-one expect to do less work, and fifty-four more work. Some make a very decided drop, as from 105 miles to 20 miles or from 52 to 22; or increase from 2 miles to 50 or from 19 to 77; but the majority indicate only small changes of 10 to 50 percent one way or the other.

Width of Bridges

We were very agreeably surprised at the replies to that question in our county highway questionnaire asking the "roadway width of bridges and culverts you will build this year." We hope that on all state highways these are being built at least as wide as the paved portion of the highway of which they form a part; but we thought it probable that many counties were not yet up to this standard.

As a matter of fact, we find that county bridges to be built this year average four feet wider than the improved surfaces of the highways in such counties. The improved surfaces range from 7 ft. (in one county) to 40 ft. (in two counties), 56 percent being from 16 to 20 ft. wide. The bridges range from 10 ft. (in one county) to 44 ft. (in one county), 55 percent being from 20 to 24 ft. wide.

Grouping the counties, we find in 5 percent of them the improved surfaces range from 7 to 9 ft. wide and the bridges from 10 to 14 ft. In the next 15 percent the improved surfaces range from 10 to 14 ft. and the bridges are 16 or 18. In the next 55 percent the figures are 16 to 20 ft. and 20 to 24 ft. respectively. In the next 15 percent the figures are 22 to 24 ft. and 26 to 30 ft.; and in the final 10 percent, 26 to 40 and 36 to 44, respectively.

These figures include several hundred counties distributed throughout most of the states and all sections of the country. While bridges of 10 to 14 ft. are too

narrow to permit vehicles to pass on them, only 4 percent of the counties report bridges as narrow as this, and 72 percent report 20 ft. width or greater. It is easily conceivable that in most or all of the 4 percent, the bridges are to be built on roads carrying such light traffic that meeting at a bridge is a rare occurrence, and impossibility of passing on it is an infrequent minor inconvenience to a very few users of the road.

There are thousands of bridges in the country that are too narrow for the important highways that cross them; but these figures would indicate an improvement in the condition is as rapid as could be expected.

Baltimore Street Cleaning Bureau

The Bureau of Street Cleaning of Baltimore, Md., is a unit of the Department of Public Works. The personnel includes 21 classified foremen, 317 men in the sanitary department for collecting garbage and ashes, 340 men in the department of street cleaning, and 34 chauffeurs, automobile shop repair men, blacksmiths, scowmen, and others.

The collection of garbage and ashes in the new annex to the city is done under contract by eight contractors. Early in 1927 a contract was awarded to the Providence Oil Service Co. for a period of two years to "regulate the handling, storage and disposition of waste oils and greases resulting from the use, operation, and servicing of vehicles, machinery, or appliances of any kind upon all premises." This seems to have been very successful during the years 1927 and 1928, and there have been practically no complaints of the service.

The motor equipment of the Bureau consists of twenty-eight 5-ton trucks, Ford cars used by the foremen, and cars for scavengers for the collection of animals weighing less than 200 pounds. (Animals weighing over 200 pounds are collected under contract by the Standard Wholesale Phosphate Company.) During 1928 the nine flushing machines formerly used by the department were converted into trucks, and a pick-up sweeping machine substituted for them. Also four trucks purchased about twelve years ago were found to be costing so much in upkeep that these also were discarded.

The Department owns about 195 horses and carts and hires some carts and trucks in addition. It also has a floating equipment of twelve scows, seven of which are used for transporting garbage to the plant of the Sanitary Reduction Company and five for taking ashes to tidewater, where they are unloaded. Ashes are generally disposed of at the nearest dump, but in many instances these are so far from the respective collection routes as to make the hauling expensive and delay the service; and ashes from these points are taken to the ash scows; this practice being confined principally to the central and southeastern portions of the city.

The collection of garbage from the large hotels in both the central part of the city and from many others outside of the business district is done at night because of the traffic conditions.

In the matter of street cleaning, eight districts are cleaned during the day, the 8th district is cleaned both day and night, and the 9th and 12th districts, which are in the central part of the city, are cleaned at night only. The department also cleans, principally at night, eleven markets covering an area of 105,791 square yards. Household rubbish is collected by contract, which was awarded to a company in 1926 for a period of five years. This contractor collected 83,000 tons of household rubbish in 1928.

Two incinerators are used but are no longer under the jurisdiction of the Bureau of Street Cleaning, but were transferred in the early part of 1928 to the Bureau of Mechanical and Electrical Service.

During the year the bureau collected 67,383 tons of garbage, 150,000 tons of ashes, and about 30,000 animals weighing less than 200 pounds each.

Engineer Control of Concrete at Akron

Results from testing cores from pavements led to better control by engineers, scientific proportioning and better curing

By M. D. Wilson and D. G. Cackler*

The city of Akron, O., has been testing all concrete work since 1923. Pavements are tested by drilling cores from them and by means of 6" x 12" cylinders. Concrete in curbing, retaining walls and other structures is tested by means of cylinders.

Cores are tested for thickness and compressive strength. Very little trouble is experienced with short cores. We allow a deficiency of ½" on individual cores providing the average of all cores on the job equals the thickness required. Any concrete base with a deficiency of more than ½" is removed and replaced with base of the proper thickness. In the case of a short core from a concrete pavement where removing the thin concrete would leave an ugly patch, an equitable deduction is made. Cores drilled in 1928 averaged 0.30 of an inch in excess of the required thickness.

The first serious efforts to increase the strength of our concrete were made in 1925. Our methods of concrete control were based upon the data furnished by the Portland Cement Association. The first year was spent in selling our ideas to the contractors and material men, educating our inspectors and engineers, and working out the means of applying the known facts about concrete to our jobs without working a hardship upon anyone. As soon as new methods were found to be practical our specifications were revised so as to make their use possible.

When the contractors found that our methods did not increase their costs, and actually saved them money in many cases, they were more willing to cooperate. The second year the strength of our concrete base rose to almost 2500 pounds per square inch at 28 days. The third year, or in 1927, another slight rise in strength was obtained. This increase was not large enough to satisfy us and we undertook to find out why. The answer seemed to be better curing.

Prior to 1928 our specifications required that all concrete in street work be kept sprinkled for ten days

*Assistant Engineers, Bureau of Highways, Akron, O.

AVERAGE 28 DAY CORE STRENGTHS IN LBS. PER SQ. IN.

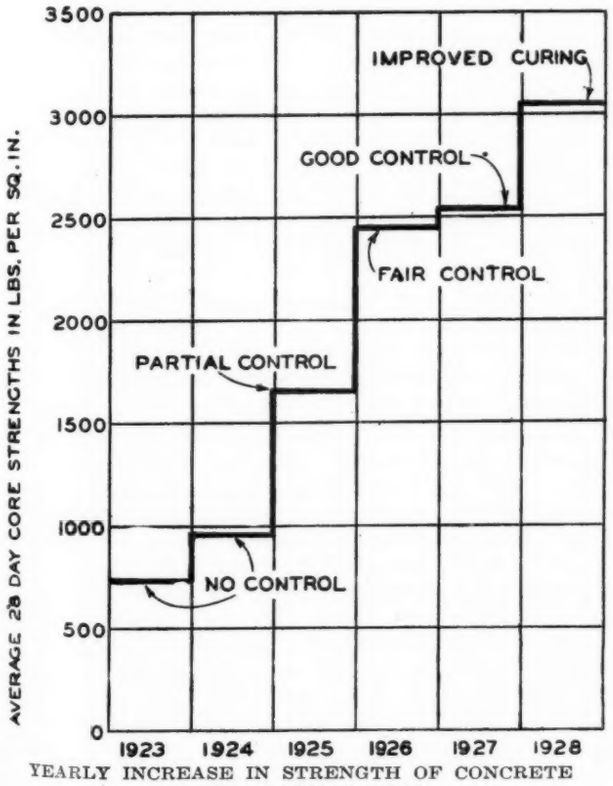
after laying. We found it almost impossible to adequately enforce this provision. In 1928 we revised our curing specification to provide that wet burlap be kept on the concrete for the first twenty-four hours and then three inches of wet straw were required for the next six days. Also we paid a small amount for curing where before it had been included in the price of the base. The average price paid was 3.4 cents per square yard. This scheme worked much better and there were very few cases where the contractor did not fully comply with the requirements. The result of adequate curing was that our average strength for concrete base jumped to over 3000 pounds per square inch at 28 days. We also had an alternate method of curing by means of ponding, but due to the many steep grades which required frequent dikes, our contractors prefered the wet straw method.

Next year we will also allow the use of an asphaltic cement seal coat for curing.

Aside from the increased strength, the concrete cured by 1928 methods was remarkably free from checking and hair cracks. All concrete curb was protected with wet burlap for three days and next year we are requiring that sidewalks also be cured the same as curbing.

The following table of declining prices proves that our methods worked no great hardship upon either contractor or material dealer:

	Bid Price-7" Base, Strength, in Lbs.		
Year	*3" Asphalt Top per square inch*		*Conditions*
1923	$3.65	734	No control
1924	3.49	966	No control
1925	3.14	1666	Partial control
1926	3.08	2461	Better control
1927	3.05	2542	Good control
1928	2.87	3056	Improved curing



YEARLY INCREASE IN STRENGTH OF CONCRETE BASE AT AKRON, OHIO

Due to the fact that our core drill is now six years old and of an obsolete model, some trouble was experienced with it this past season. It is our belief that with a modern drill we will have a smaller range between our high and low cores. However, in 1928, 65% of our cores fell within the range of 25% either way from the average. Eighty percent were within the range of 2000 to 4000 pounds per square inch.

Back in the days of the stock pile of material on the street, our mix for base was 1; 2½; 5. At that time no one thought of the allowance for the bulking of sand, consequently we have held to 1:7½ as our mix, without allowance for bulking. We did vary the ratio of sand to gravel, to get a dense, workable concrete. Next year we propose to use a 1:7½ mix making allowance for the bulking of aggregates. This will probably lower our strength, as a little more water will be necessary with this increased amount of aggregate. Our maximum allowable slump for base is 2".

The engineers in charge of concrete work spend considerable time collecting data and making continuous studies in an effort to keep informed on the most up-to-date methods. All testing work is done in the Bureau of City Tests at the Municipal University. Every effort is made to keep our specifications in line with the most modern practice. We have just finished revising them for next year and have made provisions for the use of central mixing plants and truck mixers, under proper restrictions, as well as the changes previously mentioned. We are planning to make use of the beam test as soon as it is standardized and are starting a series of tests in the endeavor to accelerate the setting during the cold weather of the late fall.

The work of the Bureau of Highways is under the direction of F. E. Swineford, director of public service; E. A. Kemmler, highway engineer; F. W. Robertson, construction engineer; D. G. Cackler and M. D. Wilson, ass't. engineers in charge of the concrete control.

Roadside Beautification

What the several states are doing toward preserving and planting trees and shrubbery

The Vermont State Chamber of Commerce is conducting a campaign for roadside beautification with the slogan "Radiant Roadsides to Match Perfect Pavements." In February it issued a special good roads bulletin giving the result of a preliminary survey based on correspondence with state highway engineers. With the bulletin goes a map printed in colors showing the status of the several states on this subject of roadside beautification. For instance, it shows that in Oregon, California, Oklahoma, Missouri, Michigan, Pennsylvania, Massachusetts, Rhode Island, and Connecticut, beautification and landscape work and the acquirement of desirable adjacent property is performed by state highway departments, financed as regular maintenance expenditures or from special funds, and for the most part professionally directed and supervised. Louisiana, Georgia, and South Carolina reported expectation of highway department beautification and landscape activity within the next

year or two; or, as in the case of South Carolina, a setting up in process by the state highway department of judicial circuit beautification organizations to be financed by private funds. Indiana reports systematic promotion and cooperation, and Illinois official permits and supervision, by state highway departments in connection with the activity of local private organizations.

Arizona, Colorado, Minnesota, Wisconsin, Arkansas, Kentucky, Alabama, Florida, North Carolina, Virginia, West Virginia and Vermont report activity, more or less widespread, on the part of state and local citizen organizations or individual citizens, with more or less cognizance, encouragement, and cooperation from state highway departments, and in one case from the state forestry department.

All of the other states are engaged in some beautification and landscape work, if it is only keeping down weeds and keeping signs from the right of way, seeding the shoulders to hold them and grassing the slopes of cuts and fills to prevent erosion. Washington, for example, stimulates and capitalizes the interest and enthusiasm of individual citizens living along the highways by providing by a law passed in 1927 that "Owners of property adjacent to the state highways may be permitted to plant lawns, trees, shrubbery, etc., on the right of way of the state highway, provided such planting does not interfere with the maintenance or construction of the highway." A law of 1925 had already made it "a misdemeanor to cut down, remove, destroy or uproot any flowering or ornamental tree or shrub or any flowering plant, either perennial or annual, or any part thereof, within 300 feet of the center line of any state or county road within the state." Idaho reported "attempting to install roadside highway parks." Utah, "intention to experiment with trees which may withstand arid climate." New Mexico gives instruction to spare trees, spare prehistoric ruins even if it necessitates relocating a bridge or highway. Iowa is preparing to establish "little parklets."

Where roadside protection and beautification has been placed by law in the hands of the state highway department, it has set up in the department an organization such as a landscape division, forestry unit, etc., or made a beginning through the employment of specialists who supervise the beautification activities of the employees of the department and of civic organizations. As examples, Missouri has "recently engaged a landscape architect, primarily for the purpose of supervising the necessary planting along the shoulders and side slopes to prevent their washing." California last season employed a landscape engineer and definite regulations governing the trimming and clearing up of the roadsides have been adopted. In Pennsylvania "an experienced forester is in charge of the work, assisted by eight division foresters, who will supervise the work in the various highway districts. The maintenance crews will carry out the work of beautification and protecting the roadsides under the supervision of the division foresters." Massachusetts maintains a nursery "where trees and shrubs are propagated and where the highway landscape supervisor trains men in the care of trees and roadside beautification. This nursery is a part of the maintenance division." During 1928 the landscape division of Connecticut "had ten landscape gangs at work throughout the state trimming trees and cutting brush along scenic routes to open up vistas hitherto closed to the passerby." In securing men for these groups, they endeavored to get into each group two or three young men who had a training as tree specialists and two or three who had had landscape training and are used to planting and maintenance of young trees and shrubbery.

In Massachusetts, "the object is to keep the roadside as natural as possible by the use of native material. Importations may be attractive, but they do not reflect the personality of the state. The men engaged in this work are advised to study how nature plants and imitate it as far as possible." In Connecticut, "young shade trees are being planted on newly constructed routes and there has already been considerable roadside planting of shrubbery on new rights of way where there is no native growth. Special attention is being given to the slopes along the newly constructed roads and their seeding and planting as soon as possible after the construction work is completed. In some cases where slopes are too high and too steep to be seeded to grass, vines are being planted. Rambler roses have been used in various parts of the state. Slopes in Norfolk were planted with rambler roses in the fall of 1927, and woodbine, honeysuckle, and other vines, which beautify the slopes and protect them from washing down into the roads, are often used." New Jersey reported "replacing, two for one, all trees which it is necessary to remove in connection with the improvement or reconstruction of state highways."

Springs are utilized in some states, Massachusetts making them available for travelers and providing benches in suitable places beside them. In Oregon, the highway commission has acquired property on which there is good water supply for drinking purposes, some in timbered regions and others in desert regions, the water rights having been secured to protect the supply for the general use of the public. In Connecticut, Michigan, Iowa, Wisconsin, and New Jersey, small parks have been developed at road intersections, especially utilizing in many cases the small triangular areas of land left in rounding the corners into long, easy curves. Idaho is attempting to install a system of roadside highway parks, the Department of Public Works advocating legislation for permission to secure points of scenic and historic interest adjacent to the highways. Missouri, Massachusetts and Pennsylvania are removing undergrowth at hilltops and other points where desirable view or vistas may be had from the roadside.

According to this Vermont bulletin, the greatest unanimity was found in replies to questions as to signs. Several of the states replied that they were doing nothing towards beautifying the roadsides other than removing advertising signs. Unfortunately, it seems impossible to prevent the placing of signs on private property along the roadside, except perhaps within city limits. The only remedy which seems to be generally applicable and one which certainly would work in time, would be for every motorist to make a note of all the firms whose advertisements he sees on billboards along the highway, firmly resolving never to purchase any of the articles or have dealings with any of the firms which so advertise.

County Highway Work During 1928

Mileage of each kind of improvement and money spent in constructing same and in maintenance

MONEY FROM ALL SOURCES SPENT IN 1928

	Money Spent in 1928	Amount Spent for Maintenance	To Be Spent in 1929
Tallapoosa, Ala.	$120,000	$85,000	$85,000
Cleveland, Ark.	18,000	8,000	20,000
Columbia, Ark.	45,000	20,000	45,000
Conway, Ark.	22,385	12,000	28,000
Desha, Ark.	23,000	23,000	28,000
Frankling, Ark.	30,000	10,000	32,000
Fulton, Ark.	14,000	14,000	13,000
Mena, Ark.	17,000	most all	17,000
Washington, Ark.	35,000	5,000	40,000
Alameda, Calif.	675,000	421,000	700,000
Fresno, Calif.	782,000	782,000	1,130,000
Napa, Calif.	220,000	40,000	200,000
Garfield, Col.	115,000	50,000	115,000
Lake, Col.	27,417	27,417	25,000
New Castle, Del.	1,000,000	163,368	...
St. Lucie, Fla.	103,000	88,000	100,000
Santa Rosa, Fla.	150,000	50,000	60,000
Sarasota, Fla.	545,792	115,107	50,000
Bonner, Idaho	118,026	50,000	140,000
Elmore, Idaho	6,000	6,000	11,000
Kootenai, Idaho	59,288	37,863	60,000
Madison, Idaho	5,000	3,750	6,000
Bureau, Ill.	140,000	60,000	150,000
Carroll, Ill.	172,000	36,000	372,000
Fulton, Ill.	145,000	45,000	85,000
Hancock, Ill.	48,000	18,000	48,000
Henderson, Ill.	35,000	25,000	31,000
Iroquois, Ill.	350,000	80,000	260,000
Jasper, Ill.	12,000	4,000	20,000
Kane, Ill.	250,000	28,000	400,000
Saline, Ill.	250,000	5,000	...
Sangamon, Ill.	400,000	90,000	350,000
Vermilion, Ill.	30,000	30,000	200,000
Wayne, Ill.	140,000	8,000	50,000
White, Ill.	78,000	35,000	100,000
Williamson, Ill.	415,000	35,000	160,000
Angola, Ind.	108,000	38,000	95,000
La Grange, Ind.	45,000	...	50,000
Randolph, Ind.	123,000	90,000	135,000
Shelby, Ind.	82,428	25,000	90,000
Tippecanoe, Ind.	125,000	...	136,000
White, Ind.	125,000	80,000	125,000
Adams, Ia.	28,098	28,037	30,000
Bremer, Ia.	45,569	10.675	45,500
Buena Vista, Ia.	143,529	47,648	125,000
Calhoun, Ia.	132,618	54,559	140,000
Cass, Ia.	120,184	27,982	38,356
Chickasaw, Ia.	64,094	25,800	50,000
Clayton, Ia.	174,000	50,000	120,000
Crawford, Ia.	70,000	30,000	70,000
Decatur, Ia.	38,231	30,611	50,500
Fremont, Ia.	95,000	29,642	110,000
Guthrie, Ia.	300,000	75,000	300,000
Mitchell, Ia.	110,528	54,622	50,000
Monroe, Ia.	30,649	25,858	30,000
Page, Ia.	63,000	52,000	64,000
Winneshiek, Ia.	74,519	35,946	76,000
Cimarron, Kans.	75,000	20,000	93,000
Clark, Kans.	100,450	39,389	60,000
Coffey, Kans.	120,000	30,000	50,000
Finney, Kans.	128,000	56,000	65,000
Kingman, Kans.	268,000	38,000	45,000
La Crosse, Kans.	67,500	21,000	60,000
Lyon, Kans.	350,000	150,000	300,000
Morris, Kans.	83,267	40,000	85,000
Reno, Kans.	500,000	120,000	300,000
Rooks, Kans.	112,000	45,000	50,000
Bell, Ky.	...	...	129,000
Campbell, Ky.	167,979	70,000	140,000
Kenton, Ky.	130,000	110,000	350,000
Scott, Ky.	70,000	14,000	65,000
Shelby, Ky.	63,450	63,450	60,000
East Carroll, La.	44,850	27,428	26,000
Easton, Md.	55,000	20,000	55,000
Essex, Mass.	102,160	None	232,000
Plymouth, Mass.	149,511	None	168,850
Calhoun, Mich.	200,000	110,000	225,000
Chippewa, Mich.	200,000	160,000	200,000
Crawford, Mich.	21,000	2,000	15,000
Dickinson, Mich.	184,066	48.566	118,000
Gogebic, Mich.	142,000	37,500	165,000
Hillsdale, Mich.	290,000	95,000	215,000
Ionia, Mich.	188,500	41,776	162,000
Jackson, Mich.	356,000	130,000	375,000
Kalamazoo, Mich.	481,358	178.767	450,000
Keweenaw, Mich.	85,000	40,000	100,000
Menominee, Mich.	211,201	102,510	250,000
Montmorency, Mich.	25.518	1,731	6,000
Oakland, Mich.	3,748,858	579,583	3,170,000
Van Buren, Mich.	128,055	89,302	150,000
Wexford, Mich.	61,672	24,135	61,672
Blue Earth, Minn.	198,000	52,000	225,000
Carlton, Minn.	80,623	24,608	100,000
Carver, Minn.	163,741	39,000	155,000
Clay, Minn.	136,000	9,500	133,000
Cottonwood, Minn.	90,000	30,000	70,000
Faribault, Minn.	223,987	68,668	200,000
Goodhue, Minn.	327,620	76,949	100,000
Hubbard, Minn.	44,053	13,133	60,000
Jackson, Minn.	154,574	46,044	147,637
Kandiyohi, Minn.	110,000	40,000	110,000
Koochiching, Minn.	10,000	10,000	10,000
Lac qui Parle, Minn.	130,486	34,470	123,250
Lake, Minn.	73,000	22,000	60,000
Mahnomen, Minn.	33,000	7,600	35,000
McLeod, Minn.	92,801	30,260	155,000
Mower, Minn.	170,016	80,130	183,711
Murray, Minn.	110,000	35,000	100,000
Pine, Minn.	95,326	23,930	100,000
Pennington, Minn.	58,550	13,182	60,000
Red Lake, Minn.	48,627	24,566	48,000
Rock, Minn.	44,454	14,409	50,000
Roseau, Minn.	53,098	10.286	...
St. Louis, Minn.	2,245	1,125	2,045
Scott, Minn.	170,895	35,396	140,000
Sibley, Minn.	286,933	31,069	269,000
Steele, Minn.	128,420	46,824	115,000
Stevens, Minn.	80,571	26,889	58,000
Wadena, Minn.	72,615	17,000	70,000
Waseca, Minn.	155,000	25,000	150,000
Washington, Minn.	123,973	19,673	115,000
Winona, Minn.	150,000	70,000	175,000
Neshoba, Miss.	75,000	6,000	80,000
Yalobusha, Miss.	65,000	6,000	25,000
Arthur, Nebr.	5,342	All	4,000
Richardson, Nebr.	60,000	15,000	70,000
Burlington, N. J.	252,000	202,000	238,000
Luna, N. M.	8,000	4,000	9,000
Albany, N. Y.	415,689	231,013	448,371
Chautauqua, N. Y.	708,170	32,470	700,000
Essex, N. Y.	382,729	...	380,000
Herkimer, N. Y.	989,643	104,201	1,038,000
Madison, N. Y.	350,000	175,000	350,000
Niagara, N. Y.	452,634	90,000	550,000
Orleans, N. Y.	205,000	5,000	225,000
Sullivan, N. Y.	250,000	80,000	250,000
Ulster, N. Y.	273,333	...	...
Beaufort, N. C.	142,752	114,480	183,000
Guilford, N. C.	429,910	212,858	...
Mecklenburg, N. C.	390,000	170,000	...
Montgomery, N. C.	40,000	33,000	40,000
Nash, N. C.	88,000	38,000	45,000
Sampson, N. C.	120,000	100,000	100,000
Burke, N. D.	20,000	5,000	20,000
Eddy, N. D.	15,000	2,100	17,000
Foster, N. D.	29,635	525	35,000
La Moure, N. D.	65,000	40,000	65,000
McLean, N. D.	109,000	16,000	120,000
Traill, N. D.	40,000	14,000	40,000
Adams, Ohio	53,000	32,000	47,000
Carroll, O.	105,000	40,000	125,000
Coshocton, O.	233,000	74,000	250,000
Defiance, O.	92,500	40,000	93,000
Logan, O.	89,000	89,000	92,000
Medina, O.	407,000	50,000	407,000
Morgan, O.	185,802	75,583	105,000
Paulding, O.	115,977	40,000	...
Scioto, O.	300,000	170,000	300,000
Tuscarawas, O.	375,000	177,000	330,000
Warren, O.	130,000	...	130,000
Wayne, O.	160,000	40,000	150,000
Douglas, Ore.	260,000	100,000	260,000
Jackson, Ore.	298,212	42,591	250,000
Lane, Ore.	845,550	85,000	850,000
Linn, Ore.	386,270	275,000	400,000
Yamhill, Ore.	140,000	20,000	140,000
Chester, S. C.	85,000	60,000	67,000
Darlington, S. C.	117,000	52,000	105,000
Marlboro, S. C.	90,000	40,000	90,000
Orangeburg, S. C.	163,000	40,000	163,000
Saluda, S. C.	125,000	None	...
Beadle, S. D.	156,859	32,684	90,000
Bon Homme, S. D.	110,000	31,000	140,000
Clay, S. D.	90,112	30,250	90,000
Day, S. D.	115,000	34,000	115,000
Davison, S. D.	66,131	9,100	...
Haakon, S. D.	58,449	22,749	55,000
Perkins, S. D.	126,250	35,911	120,000
Hutchinson, S. D.	61,463	11,023	65,000
Spink, S. D.	85,000	12,000	161,000
Union, S. D.	101,650	24,650	98,836
Yankton, S. D.	120,000	25,000	130,000

	Money Spent in 1928	Amount Spent for Maintenance	To be Spent in 1929
Ziebach, S. D.	52,000	22,000	40,000
Dyer, Tenn.	500,177	...	500,000
Hickman, Tenn.	20,000	12,000	35,000
Lawrence, Tenn.	12,000	...	...
Maury, Tenn.	45,000	30,000	75,000
Brazoria, Tex.	48,000	12,000	25,000
Ellis, Tex.	500,000	None	500,000
Giddings, Tex.	110,000	25,000	40,000
Matagorda, Tex.	800,000	None	900,000
Titus, Tex.	108,000	...	100,000
Clallam, Wash.	250,000	100,000	450,000
Lincoln, Wash.	215,000	80,000	270,000
Thurston, Wash.	182,127	121,854	190,000
Walla Walla, Wash.	381,399	246,920	378,755
Whatcom, Wash.	170,991	84,140	188,174
Berkeley, W. Va.	100,000	30,000	100,000
Keyser, W. Va.	30,000	25,000	35,000
Nicholas, W. Va.	54,300	17,300	...
Preston, W. Va.	120,000	70,000	110,000
Putnam, W. Va.	90,000	50,000	50,000
Raleigh, W. Va.	125,000	35,000	100,000
Adams, Wisc.	228,116	65,539	...
Brown, Wisc.	600,000	145,000	450,000
Burnett, Wisc.	200,000	100,000	...
Iowa, Wisc.	300,000	110,000	300,000
Jackson, Wisc.	350,000	100,000	500,000
Richland, Wisc.	505,144	110,089	595,834
Rusk, Wisc.	125,000	60,000	150,000
Washington, Wisc.	248,000	35,000	250,000
Waupaca, Wisc.	600,000	93,560	700,000

Bituminous Surface Treatment by Counties

County and State	Miles Given Surface Treatment	Type of Road Surfaced	Cost of Surface Treatment per Mile	Material Used
Alameda, Calif.	22	Gravel	$1500.00	Emuls. Asph.
Fresno, Calif.	1000	Earth	250.00	Crude Oil
New Castle, Del.	125	W. B. Mac.	.07 sq. yd.	Tar & Asph.
St. Lucie, Fla.	2	W. B. Mac.	.12 sq. yd.	Asph.
Sarasota, Fla.	43	Lime Rock	2400.00	Tar & Asph.
Carroll, Ill.	5	Earth	200.00	Asphalt
Hancock, Ill.	31	Earth	300.00	Oil
Iroquois, Ill.	100	Earth	200.00	Asph. Oil
Sangamon, Ill.	150	Earth	250.00	Oil
Randolph, Ind.	12	Gravel	1800.00	Tar
Chickasaw, Iowa	10	Gravel	1500.00	
Reno, Kans.	¼	Sand-Clay	1000.00	Asphalt
Campbell, Ky.	4.5	W. B. Mac.	169.00	Oil
Scott, Ky.	50	W. B. Mac.	450.00	Tar
Shelby, Ky.	5			Asphalt
Dickinson, Mich.	8	Gravel	850.00	Asphalt
Gogebic, Mich.	12	Gravel	1000.00	
Kalamazoo, Mich.	60	Gravel	800.00	Tar & Asph.
Keweenaw, Mich.	6	W. B. Mac.	800.00	Tar
Menominee, Mich.	20	Grav. & Mac.	800.00	Tar & Asph.
Van Buren, Mich.	3		2200.00	Cutback Asph.
Carver, Minn.	2.5	Gravel	3400.00	Asphalt
St. Louis, Minn.	170	Gravel	1900.00	Tar & Asph.
Burlington, N. J.	140	Gravel & Mac.	500-700	Tar & Asph.
Chautauqua, N. Y.	10	Gravel	400.00	Tar
Herkimer, N. Y.	100	Macadam	438.00	Tar
Madison, N. Y.	30	Macadam	300.00	Tar & Asph.
Niagara, N. Y.	200	Bit. Mac. & Conc.	385.00	Tar & Asph.
Orleans, N. Y.	2	Bit. Mac.	600.00	Asphalt
Sullivan, N. Y.	200	Bit. & W. B. Mac	300.00	Tarvia & Asph.
Defiance, O.	30		900.00	Tar
Logan, O.	1		1500.00	Tar
Medina, O.	9		450.00	Tar & Asph.
Tuscarawas, O.	23	Mac. & Grav.	1600.00	
Warren, O.	9	Mac. & Grav.		Tar
Linn, Ore.	13	Mac.	1,000.00	Asphalt
Ellis, Tex.	80	Gravel	1700.00	Asphalt
Giddings, Tex.	43	Gravel	2,000.00	Asphalt
Titus, Tex.	28	Gravel	1950.00	Asphalt
Thurston, Tex.	4	Gravel	5000.00	Tarvia
Putnam, W. Va.	1.3	Bit. Mac.	2500.00	Tar
Raleigh, N. C.	15	Bit. Mac.	1000.00	Asphalt
Richland, Wisc.	1		786.00	Tarvia
Waupaca, Wisc.	5	Gravel	2000.00	

Gravel

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Tallapoosa, Ala.	30	..	..
Columbia, Ark.	5	..	..
Alameda, Calif.	..	362	18
Napa, Calif.	12	250	18
St. Lucie, Fla.	2M	118	9-16
Bonner, Idaho	15	78.2	66
Bureau, Ill.	8	750	20
Carroll, Ill.	7	40	14
Iroquois, Ill.	3.9	42	14
Kane, Ill.	50	800	15-20
Wayne, Ill.	35	45	7-10
White, Ill.	14	250	8
Williamson, Ill.	..	2	18
Angola, Ind.	18	..	16
Randolph, Ind.	9	..	..
Tippecanoe, Ind.	..	660	18
Shelby, Ind.	15	531	18
White, Ind.	15	250	24
Bremer, Ia.	4	35.2	..
Buena Vista, Ia.	60	522	26
Calhoun, Ia.	117	517	24-26
Clayton, Ia.	5	7	..
Crawford, Ia.	23	70	..
Guthrie, Ia.	10	60	22
Mitchell, Ia.	12.8	35.9	..
Winnesheik, Ia.	0.8	16.3	24
Cimarron, Kans.	8	15	30
Coffey, Kans.	7	15	18
La Crosse, Kans.	17	24	30
Lyon, Kans.	13	40	22
Morris, Kans.	8	8	30
Shelby, Ky.	..	300	14
East Carroll, La.	10	83	24
Easton, Md.	..	2	..
Calhoun, Mich.	18	268	10-12
Chippewa, Mich.	10	104	18
Crawford, Mich.	5	22	9
Dickinson, Mich.	4	34	24
Hillsdale, Mich.	17	209	16
Ionia, Mich.	14.5	343	..
Jackson, Mich.	30	355	9
Kalamazoo, Mich.	33	286.5	9-16
Keweenaw, Mich.	4	..	..
Menominee, Mich.	20	195	12-20
Montmorency, Mich.	3	..	24
Oakland, Mich.	13	388	9-16
Van Buren, Mich.	20	189	9-16
Blue Earth, Minn.	..	260	24
Carlton, Minn.	13	209	..
Cottonwood, Minn.	20	152	18
Faribault, Minn.	46	..	20-24
Goodhue, Minn.	17	236	24
Hubbard, Minn.	..	17.5	..
Jackson, Minn.	17.5	165	20
Kandiyohi, Minn.	12	248	24
Lac qui Parle, Minn.	33.3	166	24
Lake, Minn.	8	400	18
Mahnomen, Minn.	..	10	24
McLeod, Minn.	17	800	24
Murray, Minn.	18	150	24
Pine, Minn.	32	56.5	..
Pennington, Minn.	..	130	20-24
Red Lake, Minn.	3.8	68	24
Rock, Minn.	..	123	24
Roseau, Minn.	12.6	56	20
Scott, Minn.	16	70	..
Sibley, Minn.	86.4	..	..
Steele, Minn.	11C	..	22
Stevens, Minn.	56	..	24
Waseca, Minn.	12.5	155	24

Gravel

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Washington, Minn.	6	80	26
Winona, Minn.	11	125	16
Yalobusha, Miss.	15	..	..
Richardson, Nebr.	11	47	30
Burlington, N. J.	..	82.6B	18-20
Albany, N. Y.	23.5A	204A	14
Chautauqua, N. Y.	..	18	..
Essex, N. Y.	16	20	..
Herkimer, N. Y.	13.7M	207	10
Sullivan, N. Y.	20A	106A	14
Mecklenburg, N. C.	..	99	24
Montgomery, N. C.	..	20	20
Eddy, N. D.	20	50	..
Foster, N. D.	6	58	..
La Moure, N. D.	17	..	28
McLean, N. D.	4	..	20
Traill, N. D.	5.5	29	24
Carroll, O.	..	85	16
Holmes, O.	25	100	16
Logan, O.	1.5	670	..
Medina, O.	53TM	170	14
Morgan, O.	35	..	20
Paulding, O.	15.5	850	10
Tuscarawas, O.	35.6S	254	14
Wayne, O.	80S	200	15
Douglas, Ore.	15	797	12
Jackson, Ore.	24.8	250	12-16
Lime, Ore.	20	650	18
Yamhill, Ore.	10	1500	10-16
Marlboro, S. C.	80	600	36
Bon Homme, S. D.	7	93	24
Clay, S. D.	8.5	110	24
Day, S. D.	23	..	..
Davison, S. D.	25	40	..
Haakon, S. D.	..	42	24
Spink, S. D.	14	..	..
Union, S. D.	34	122	22
Yankton, S. D.	25	150	24
Hickman, Tenn.	24	240	20
Maury, Tenn.	..	500	24
Brazoria, Tex.	8Sh	..	18
Giddings, Tex.	..	32	16
Titus, Tex.	28	..	18
Clallam, Wash.	18	..	..
Lincoln, Wash.	30	275	24
Thurston, Wash.	4	1046	18
Walla Walla, Wash.	..	295	18
Whatcom, Wash.	25	325	16-26
Nicholas, W. Va.	..	50	..
Putnam, W. Va.	5	7	16
Adams, Wisc.	3	70	16
Brown, Wisc.	60	..	12-30
Burnett, Wisc.	10	..	26
Iowa, Wisc.	50	..	..
Richland, Wisc.	32	..	22
Rusk, Wisc.	12	..	..
Washington, Wisc.	27	..	..
Waupaca, Wisc.	35.6	..	..

M—Macadam; A—partly macadam; B—oiled; C—crushed; S—gravel and Slag; Sh—shell; TM—Traffic-bound.

Sand-Clay or Top Soil

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Columbia, Ark.	10	..	..
Alameda, Calif.	..	45	..
Napa, Calif.	..	100	..
White, Ind.	40	500	24
Finney, Kans.	17	30	28
La Crosse, Kans.	30	40	30
Reno, Kans.	10	200	28
Chippewa, Mich.	..	15	..
Crawford, Mich.	..	19	..
Carlton, Minn.	..	2	..
Hubbard, Minn.	7.5	72.6	..
Mower, Minn.	..	142.7	24
Red Lake, Minn.	..	1.5	24
Guilford, N. C.	8	322	16-18
Mecklenburg, N. C.	..	275	30
Montgomery, N. C.	..	25	20
Nash, N. C.	13	150	20
Jackson, Ore.	9	30	16
Chester, S. C.	18	150	18
Darlington, S. C.	53	1260	20
Saluda, S. C.	16	..	..
Davison, S. D.	..	80	..
Haakon, S. D.	24	430	..
Brazoria, Tex.	2	..	16
Giddings, Tex.	..	15	16
Adams, Wisc.	15.9	100	12

Brick

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
White, Ind.	..	4	20
Lyon, Kans.	..	1	18
Reno, Kans.	..	54	18
Campbell, Ky.	..	1.5	18

Concrete — Plain

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Alameda, Calif.	..	37	20
Napa, Calif.	5	65	18
St. Lucie, Fla.	..	20	18
Sarasota, Fla.	..	5.3	18
Kootenai, Idaho	0.25	..	..
Carroll, Ill.	3	60	18
Fulton, Ill.	2	..	16
Iroquois, Ill.	13	94.3	10-18
Sangamon, Ill.	10	115	16-18
La Grange, Ind.	..	4	16
Randolph, Ind.	..	24	16
Tippecanoe, Ind.	1.5	..	18
White, Ind.	10	10	18
Fremont, Ia.	20	20	18
Finney, Kans.	..	36	16
Lyon, Kans.	..	28	18
Morris, Kans.	..	2	18
Reno, Kans.	11	20	18
Campbell, Ky.	..	36	16
Calhoun, Mich.	4.5	8	20
Ionia, Mich.	14	43.6	..
Menominee, Mich.	0.5	9	20
Oakland, Mich.	59R	317	20-40
Madison, N. Y.	6	30	10-16
Guilford, N. C.	6.6	57	16-18
Medina, O.	2	33	9-16
Douglas, Ore.	0.2	6.7	..
Chester, S. C.	11.5	11.5	18
Orangeburg, S. C.	26	26	18
Whatcom, Wash.	1	..	16
Adams, Wisc.	2	2	20
Brown, Wisc.	8	..	18
Washington, Wisc.	5	97	20
Waupaca, Wisc.	16	..	30

Concrete Reinforced

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Kane, Ill.	3	111	18-40
Williamson, Ill.	11.5	94	10-18
Angola, Ind.	..	10	12-16
Randolph, Ind.	..	39	16
Shelby, Ind.	4	7	18
Page, Ia.	26.5	26.5	18
Kenton, Ky.	3	47	18
Sullivan, N. Y.	1	8	16
Guilford, N. C.	..	3	16
Tuscarawas, O.	1.9	5	18
Union, S. D.	3.7	4	20
Ellis, Tex.	8.8	13	18
Matagorda, Tex.	40	40	9

Bituminous Macadam

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Conway, Ark.	..	120	18
Alameda, Calif.	..	11	20
Fresno, Calif.	..	66	16
Napa, Calif.	3	3	20
Kootenai, Idaho	0.7	..	..
Williamson, Ill.	..	1.2	18
Randolph, Ind.	12	..	..
Kenton, Ky.	..	40	18
Shelby, Ky.	..	30	14
Plymouth, Mass.	16	..	20
Chippewa, Mich.	..	1	18
Jackson, Mich.	2	10	18
Burlington, N. J.	3.5	38	18-20
Albany, N. Y.	3.2	10.6	14
Chautauqua, N. Y.	20	64	..
Herkimer, N. Y.	29.4	46.8	10
Madison, N. Y.	7	170	10-16
Orleans, N. Y.	11.7	62	14-16
Sullivan, N. Y.	15	62	14
Ulster, N. Y.	25.4	151	14
Guilford, N. C.	..	6	16
Mecklenburg, N. C.	5	117	10-18
Ellis, Tex.	11.6	11.6	18
Giddings, Tex.	43	43	16
Thurston, Wash.	4	4	18
Keyser, W. Va.	4	3	20
Raleigh, W. Va.	6	75	9-18
Iowa, Wisc.	3	..	..

Bituminous Concrete

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Alameda, Calif.	2	28	24
Fresno, Calif.	..	224	16
Randolph, Ind.	6	..	..
Kingman, Kans.	5	5	18
Guilford, N. C.	4	90	16-18
Tuscarawas, O.	2	2	..

Sheet Asphalt

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Sarasota, Fla.	..	19.7	16-24

Rock Asphalt

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Randolph, Ind.	..	11.7	20
Tippecanoe, Ind.	2.8	3.3	..
Campbell, Ky.	2	4	20-38
Kenton, Ky.	..	3	

Graded Roads

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Cleveland, Ark.	200	..	..
Columbia, Ark.	400	..	16-24
Conway, Ark.	..	1000	..
Franklin, Ark.	250	500	..
Fulton, Ark.	None	600	..
Mena, Ark.	600	800	12
Fresno, Calif.	..	2300	10-20
Napa, Calif.	..	90	..
Garfield, Col.	10	..	18
Lake, Col.	None	141	8-24
St. Lucie, Fla.	5	116	30
Santa Rosa, Fla.	20.5	..	..
Sarasota, Fla.	27.75	48.75	24
Kootenai, Ida.	1	..	..
Bureau, Ill.	12	600	..
Carroll, Ill.	25	150	30
Fulton, Ill.	75	350	28
Hancock, Ill.	71	..	30
Jasper, Ill.	6	11	24
Kane, Ill.	20	..	..
Sangamon, Ill.	10	150	30
Randolph, Ind.	58	641	18
White, Ind.	None	500	24
Bremer, Ia.	6.2	8.2	26
Buena Vista, Ia.	10	10	26
Calhoun, Ia.	87	604	24-26
Cass, Ia.	0.66	..	..
Chickasaw, Ia.	9	..	26
Clayton, Ia.	11	20	26
Crawford, Ia.	4	80	26
Decatur, Ia.	46	129	24
Fremont, Ia.	3	4	28
Guthrie, Ia.	3	40	26
Mitchell, Ia.	8.2	6.0	..
Monroe, Ia.	..	121	..
Page, Ia.	1	3.5	28
Winneshiek, Ia.	4	27	26
Cimarron, Kans.	110	1100	30
Clark, Kans.	..	625	24
Coffee, Kans.	40	..	28
Finney, Kans.	10	515	24
Kingman, Kans.	100	1528	34
La Crosse, Kans.	180	1855	30
Lyon, Kans.	25	250	..
Morris, Kans.	30	1300	20-30
Reno, Kans.	40	2000	28
Rooks, Kans.	35	1250	30
Kenton, Ky.	..	100	30
Shelby, Ky.	..	100	12
East Carroll, La.	..	75	24
Easton, Md.	..	100	..
Chippewa, Mich.	5	..	..
Crawford, Mich.	6	41	9
Dickinson, Mich.	3.5	..	24
Gogebic, Mich.	5	70	16
Keweenaw, Mich.	6	..	..
Menominee, Mich.	7	40	..
Montmorency, Mich.	3	..	..
Blue Earth, Minn.	30	30	24
Carlton, Minn.	14.5	902	16-24
Cottonwood, Minn.	15	156	24
Faribault, Minn.	37	..	20-24
Goodhue, Minn.	8.5	8.5	24
Jackson, Minn.	12	187	24
Kandiyohi, Minn.	12	248	24
Lac qui Parle, Minn.	14.5	32.1	24
Mahnomen, Minn.	8	65	24
McLeod, Minn.	14	..	..
Mower, Minn.	8.25	195.7	24
Murray, Minn.	10	10	24
Pine, Minn.	17.2	76.6	24
Pennington, Minn.	21	685	20-24
Red Lake, Minn.	5.7	36	24
Rock, Minn.	3	3	24
Roseau, Minn.	3	31.6	24
Scott, Minn.	8	8	28
Sibley, Minn.	46	166	24-28
Steele, Minn.	11.5	..	24
Stevens, Minn.	12.6	135	24
Waseca, Minn.	14	20.2	24
Winona, Minn.	20	800	20-24
Neshoba, Miss.	600	700	20-24
Yalobusha, Miss.	10	..	..
Richardson, Nebr.	20	..	30
Albany, N. Y.	8.9	26.8	14

Graded Roads

County & State	Miles Built in 1928	Miles in county, end of 1928	Width of Imp'd Surface
Herkimer, N. Y.	16.2	..	..
Beaufort, N. C.	40	585	40
Guilford, N. C.	15	575	20-30
Mecklenburg, N. C.	10	..	30
Montgomery, N. C.	..	30	20
Sampson, N. C.	40	1250	..
Burke, N. D.	40	500	..
Eddy, N. D.	123	300	28
Foster, N. D.	18	102	..
La Moure, N. D.	40	..	20
McLean, N. D.	215	1500	20-24
Traill, N. D.	39.5	122	24
Adams, O.	5	5	14
Holmes, O.	15	15	24
Logan, O.	2.5	119	..
Morgan, O.	35	100	20
Wayne, O.	100	..	15
Douglas, Ore.	15	230	16
Jackson, Ore.	4	300	16-24
Yamhill, Ore.	10	500	20-30
Chester, S. C.	..	450	..
Darlington, S. C.	53	1260	20
Orangeburg, S. C.	..	610	30
Bon Homme, S. D.	66	..	24
Clay, S. D.	16	85	24
Day, S. D.	124	..	20-24
Davison, S. D.	27	..	24
Haakon, S. D.	24	472	20
Perkins, S. D.	150	800	24
Hutchinson, S. D.	61	..	24
Spenk, S. D.	35	800	24
Union, S. D.	26	262	24
Yankton, S. D.	24.5	13.5	24
Ziebach, S. D.	15	242	24
Hickman, Tenn.	110	350	20
Maury, Tenn.	600	900	..
Brazoria, Tex.	9	1125	..
Giddings, Tex.	12	25	..
Matogorda, Tex.	60	620	18
Walla Walla, Wash.	..	864	..
Whatcom, Wash.	23	498	16-26
Berkeley, W. Va.	4	60	18
Keyser, W. Va.	10	5	20
Nicholas, W. Va.	12	50	20
Preston, W. Va.	4	..	40
Putnam, W. Va.	..	4	..
Adams, Wisc.	15.9	325	24-26
Brown, Wisc.	350	..	..
Burnett, Wisc.	50	..	20
Iowa, Wisc.	85	..	..
Jackson, Wisc.	100	..	..
Richland, Wisc.	26	..	26
Rusk, Wisc.	24	..	26
Washington, Misc.	14	135	24
Waupaca, Wisc.	28.6	..	26

Calcium Chloride on State Roads

State highway engineers were asked recently, by the Columbia Products Co. of Barberton, O., (which has kindly furnished us with the replies) to what extent calcium chloride is used by their several departments as a dust palliative on gravel roads and for curing concrete.

Concerning the former, of 39 replying, 16 use it, 6 of them "some" or "slightly." Maine in 1928 treated 983 miles, Michigan 3,430 miles, Minnesota 169 miles, Ohio 100 miles, Vermont 2,200 miles; the remainder reporting less than 100 miles or not giving the mileage. Michigan expects to treat 3,650 miles in 1929, Wisconsin 120 miles, New York 50 miles. The others have no figures to give or expect to use none, the latter including two which used it last year. As reasons for not using it, several states report their climate too arid, others have very few gravel roads, in Massachusetts it is used by towns but not by the state; while New York has lessened its use, thinking it injurious to horses' feet.

Concerning use of it for curing concrete, 22 states report using it, 14 of them leaving it optional with the contractor, who is in every case the purchaser. In 12 states it is used integrally, in 7 on the surface, and in 3 both ways. It is used as an accelerator during frost periods by Iowa and Montana, and mainly in bridge construction in North Dakota.

Recent Legal Decisions

DELEGATION OF CONTRACT FOR PUBLIC WORKS

The Texas Commission of Appeals holds, Harris vs. Road Dist. No. 4 of San Jacinto County, 6 S. W. (2d) 340, that where bids for the construction of roads, culverts and bridges were duly advertised for by the county commissioners in accordance with Texas Acts 1917, c. 141, §1, and accepted by the commissioners, the commissioners' court, with the consent of the bidder, had authority to contract with another contractor, who assumed all the obligations of the bidder under its contract, for the construction of the culverts and bridges upon the terms of the accepted bid.

PROCEDURE TO SECURE DELAYED CONSTRUCTION OF HIGHWAY

The Kansas Supreme Court holds, State v. Board of Commissioners, 268 Pac. 837, that where a board of county commissioners intentionally and purposely postpones and delays action toward the construction of a highway, after it has been regularly approved as a public utility, and proceeds with the construction of two other roads petitioned for six years later, without assigning any good reason for such unusual delay, mandamus will lie to require the board to proceed with the construction of the road.

REPAIRING CONTRACTOR'S TRUCKS HELD WITHIN ROAD CONTRACTOR'S BOND

The West Virginia Supreme Court of Appeals holds, Hicks v. Randich, 144 S. E. 887, that the bond of a contractor who contracts to build a county-district road, the condition of which bond is, among other things, that the contractor shall pay all and every person furnishing material or performing labor in and about the construction of the roadway, when read together with section 104, c. 43, W. Va. Code, and section 12, c. 75, Code, renders the contractor and his bondsmen liable to a person for work done in repairing the contractor's trucks while they are being used to haul rock and material for the road base, and for the reasonable value of repair parts placed by him in the trucks while so used, although the repairs and parts are not totally destroyed by use or otherwise during the progress of the work.

CONDEMNATION PROCEEDINGS—DAMAGES BY BLASTING—OFFSETTING BENEFITS

The Tennessee Supreme Court holds, Newberry v. Hamblen County, 9 S. W. (2d) 700, that, in condemnation proceedings where the owner sought damages to his dwelling house caused by blasting in the roadway, if the injury was a necessary incident of necessary blasting in construction of the highway, the damages were chargeable to the condemnor, here the county. But if the injury was the result of the contractor's negligence, the damages were chargeable to him.

As to incidental offsetting benefits it was held that: "Increased accessibility to the owner's property, greater convenience in approach with vehicles, the advantage generally of a front on a more desirable roadway, better drainage, and a more attractive outlook, are improvements tending to enhance the value for use and sale of farm and suburban lands immediately abutting on an improved highway, and constitute special benefits for which allowance may be made. And this is true despite the fact that like benefits accrue to other properties in the neighborhood affected in like manner."

POWER TO COMPEL RECONSTRUCTION OF BRIDGE OVER NAVIGABLE RIVER

The Circuit Court of Appeals, Eighth Circuit, in Trickett v. Kaw Valley Drainage Dist., 25 Fed. (2d) 851, says: "Speaking generally, it may be conceded that the construction and maintenance of highways and bridges is exclusively within the State's police power and that it is the uniform rule, as it is in Kansas, to invest by statute in named officials, or official bodies, discretion to exercise the power, and that ordinarily a federal court cannot take to itself the right to exercise that discretion and discharge the duties thus vested in local authority. However it clearly appears from the statutes of Kansas (chapter 64, Laws of 1909) that there are contingencies like those in hand, in which judicial power is conferred to compel action by the board of county commissioners in carrying out appropriate orders of the drainage board * * * And in Kaw Valley Drainage Dist. v. Board of Commissioners, 110 Kan. 566, 572, involving this very bridge, the Supreme Court said: 'The drainage district board has power to order the removal or reconstruction of a bridge or part of a bridge which tends to increase the hazard of floods, and to conduct litigation to enforce its reasonable orders designed to that end.' "

It accordingly held that the federal district court for Kansas had jurisdiction, in a suit involving the necessary diversity of citizenship, to order the reconstruction of a bridge over a navigable river, and that the work should be done and paid for by the county.

GROCERIES FURNISHED PUBLIC WORKS CONTRACTOR FOR EMPLOYEES HELD WITHIN WASHINGTON STATUTORY BOND

The Washington Supreme Court holds, National Grocery Co., vs. Maryland Casualty Co., 269 Pac. 4, that groceries furnished a contractor on public works for use in a cookhouse or boarding house operated by the contractor at the site of the work, in this case the construction of a ferry bridge, and consumed by the employees, are within the contractor's statutory bond given pursuant to Wash. Rem. Comp. Stat. §1150, providing security for payment to all persons supplying the contractor "with provisions and supplies for the carrying on of such work." The Washington court's decisions make a distinction between "materials" as used in lien statutes and "provisions and supplies," such as groceries, meats, etc., as used in the statutes requiring bonds of this character, and follow a more liberal rule allowing recoveries for items in an action on a bond of a contractor doing public work than in an action to foreclose a lien.

STREETS NOT DIRECTLY CONNECTED MAY FORM SINGLE IMPROVEMENT

The Arkansas Supreme Court holds, Snoddy vs. Paving Improvement Dist. No. 4, 7 S. W. (2d) 972, that although streets and parts of streets which are not immediately and directly connected with each other are embraced in one improvement, the fact that they are connected together through other paved streets constitutes them the same improvement. The similarity of the improvement proposed to be made, the fact that the streets are to be improved with the same material, and the situation of the property with respect to each street or part of street to be improved, make as satisfactory a test as to whether they might all be embraced in one improvement as their actual physical connection with one another.

CITY'S POWER TO ACQUIRE LAND FOR STAND-PIPE

The Tennessee Supreme Court holds, Beadle vs. Town of Crossville, 7 S. W. (2d) 992, that a town which is authorized to operate a system of waterworks for the benefit of its citizens and to issue bonds for the undertaking of such an enterprise by its charter and acts of the Legislature is empowered, under the general statutes of eminent domain, to take land necessary and suitable upon which to locate a standpipe. Under these statutes the construction of waterworks with a necessary reservoir to supply a town or city is a "work of internal improvement" just as the construction of a railroad, turnpike and other public improvements named therein.

AUTHORITY TO CONTRACT FOR CONSTRUCTION OF COURTHOUSE

The Arkansas Supreme Court holds, Norman vs. Blair, 7 S. W. (2d) 328, that a straight contract for the construction of a courthouse, let to the lowest bidder, to be constructed according to plans and specifications therefor, the price payable in county warrants in fifteen equal annual instalments, does not offend against section 1, art. 16, of the state Constitution, forbidding the state or any city, county, town or other municipality in the state to loan its credit for any purpose whatever, and is constitutional and valid in the absence of evidence of fraud or collusion between the contracting parties that the bid should be increased by adding carrying or interest charges thereto, and including same in the warrants.

GUARANTEE FOR UPKEEP OF IMPROVEMENT CANNOT BE PROVIDED FOR BY GENERAL ORDINANCE PASSED AT EARLIER DATE

The Missouri statute, St. 1919, §8324, relative to grading and paving streets, provides that: "The council shall have the power to require any contractor doing the work to guarantee that an improvement will last for a specified term of years, and during such term will be kept in repair, and to require the contractor to give to the city approved bonds for the faithful performance of any obligation." The statute does not require the council to take such action. The matter is entirely within the discretion of the council. The Springfield (Mo.) Court of Appeals holds, City Trust Co. vs. Cunningham, 7 S. W. (2d) 456, that a general ordinance providing that "the council shall require" such a guarantee is not self-enforcing, and a paving contract entered into under a subsequent ordinance was not invalid because it did not comply with the previous ordinance in this respect. The court said: "It would seem but fair that, if a guaranty were to be required under any ordinance providing for a specific improvement, notice of it should be brought home to the contractors at or before the time they should prepare their bids, so they could understand all that was required, and take that matter into consideration in making up their bids * * * We do not understand that a city council can by one ordinance bind itself to pass another ordinance at some time in the future. The statute above which grants discretionary power to the council must mean that the discretion is to be exercised at the time the improvement is to be made, and since the council did not, at that time, violate the statute, it could not be bound by the general ordinance sought to be invoked here."

ADVERTISEMENT OR BIDS HELD NECESSARY FOR SEWER IMPROVEMENT UNDER IOWA STATUTES WHERE COST NOT ASSESSED ON OWNERS

The Supreme Court of Iowa holds, Dunn v. Sioux City, 221 N. W. 571, that a city may, under the laws of that state, make improvements in the nature of construction and repairs of sewers, and pay for the same out of the general sewer fund of the city, where there is no attempt to assess the cost of the same against abutting property owners, without passing a resolution of necessity or publishing notice, letting of the contract on competitive bids, or proceeding in other respects as provided by chapter 308 of the Iowa Code of 1927.

LIMITATION OF TIME FOR MATERIALMAN'S ACTION FOR FUND OR ON BOND

The Iowa Supreme Court holds, Perkins Builders' Supply & Fuel Co. v. Independent School Dist. of Des Moines, 221 N. W. 793, that under section 10313 of the Iowa Code of 1924, which provides that any claimant for labor or material, who has filed his claim, may at any time after the expiration of 30 days, and not later than 6 months following the completion and final acceptance of the improvement, bring action thereon, a materialman who does not bring action within such period cannot thereafter bring action against the school board for the fund, nor against the surety company on the bond, the section being a special statute of limitations. After the 6 months, however, he would still have a right of action as against the contractor until the expiration of the period of the general statute of limitations.

LIABILITY FOR INJURY TO PRISONER WORKING ON STREETS

The Mississippi Supreme Court holds, Warren v. Town of Booneville, 118 So. 290, that a municipality, in exercising the statutory duty and prerogative of the maintenance and repair of its streets, is exercising a corporate function. It is not liable for injury to a prisoner, forced to work on the streets in shackles and chains, in accordance with the authority of Hemingway's Code 1927, §6781, since the city, in working its prisoners on the streets, exercises a government function as a mere incident to the carrying out of an imposed sentence. The injury complained of was to the plaintiff's legs by the shackles and chain.

Engineering Societies

May 13-15—NATIONAL HIGHWAY TRAFFIC ASSOCIATION. Annual Convention. Stevens Hotel, Chicago. Secretary, Elmer Thompson.

May 20-23—NATIONAL CONFERENCE ON CITY PLANNING. Annual Conference at Buffalo, N. Y. Flavel Shurtleff, Secretary, 130 E. 22nd St., N. Y.

June 18-20—NEW YORK STATE CONFERENCE OF MAYORS AND OTHER CITY OFFICIALS. Annual Meeting at Binghamton, N. Y. Secretary, William P. Capes, City Hall, Albany, N. Y.

June 24-28—AMERICAN WATER WORKS ASS'N. Annual Convention at Toronto, Ont. Beekman C. Little, Secretary, 29 W. 39th St., N. Y.

Sept. 17-20—NEW ENGLAND WATER WORKS ASSOCIATION. Annual Convention at Portland, Me. F. J. Gifford, Secretary, 715 Tremont Temple, Boston, Mass.

Sept. 30-Oct. 4—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual Convention at Minneapolis, Minn. Homer M. Calver, Secretary, 370 Seventh Ave., N. Y.

Oct. 14-16 —INTERNATIONAL ASSOCIATION OF STREET SANITATION OFFICIALS. Annual Convention at Jacksonville, Fla. A. M. Anderson, Secretary, 100 North LaSalle St., Chicago, Ill.

Oct. 14-18—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual Convention at Philadelphia, Pa. C. V. S. Sammelman, Secretary, St. Louis, Mo.

Nov. 12-14—NATIONAL MUNICIPAL LEAGUE. Annual Convention at Chicago, Ill. Secretary, Russell Forbes, 261 Broadway, N. Y.

Nov 20-23—INTERNATIONAL CITY MANAGERS' ASSOCIATION. Annual Convention at Fort Worth, Tex. Executive Secretary, John G. Stutz, Lawrence, Kans.

American Water Works Association

Illinois Section.—The next meeting is to be held May 13th and 14th, 1929, at the Clayton Hotel, Waukegan, Illinois. Secretary, M. L. Enger, Professor of Mechanics and Hydraulics, University of Illinois, Urbana, Illinois.

Minnesota Section.—The next meeting is to be held jointly with the Minnesota League of Municipalities, June 12th to 14th, 1929, inclusive, at Austin, Minnesota. Secretary, R. M. Finch, Messrs. Wallace and Tiernan Company, 240 South 4th Street, Minneapolis, Minn.

New York Section.—The next meeting is to be held May 2nd and 3rd, 1929, at the Mark Twain Hotel, Elmira, N. Y. Secretary, E. D. Case, The Pitometer Company, 50 Church Street, New York, N. Y.

Pacific Northwest Section. — The next meeting is to be held May 15th and 16th, 1929, at Spokane, Washington. Secretary, Kenneth Shibley, 1005 Securities Building, Seattle, Washington.

First Annual Southeastern Road Show

The First Annual Southeastern Road Show, held at Jacksonville, March 19th to 23rd was sponsored by the Florida Road Builders Association which is made up from the Florida Engineering Society, The Florida Paving Contractors Association, The University of Florida—Engineering Department, Jacksonville Chamber of Commerce and Florida State Road Department.

Papers of the first session were those on the value of research in the planning and construction of highways by R. E. Toms, engineer of the U. S. Bureau of Public Roads in charge of the southeastern district; subgrades and foundations by Prof. F. H. Eno, research professor of highway engineering in State University of Ohio; economical improvements of highways and airports by W. E. Rosengarten of New York. George W. Simons, Jr., Jacksonville, described the traffic surveys made at various points in the city and showed their use in designing location of new streets, width of pavements, by-pass streets and boulevards.

Other papers included a discussion of materials. John E. Walker, Highway Engineer of Marion County spoke on Florida limerock; C. E. Ireland of Birmingham on slag; C. W. Stone of Jacksonville on Florida broken or crushed stone; and J. F. Seiler of the American Wood Preservers Association on creosoted wood for highway structures. E. V. Camp presented a paper on Highway Guard Rail Economics.

New Jersey Sewage Works Association

The annual meeting of this association was held at the Stacey-Trent Hotel, Trenton, N. J., March 22 and 23. The attendance of about 200 was, as usual, representative of most of the eastern states. Officers were re-elected as follows: President, Edward F. Shissler, Haddon Heights, N. J.; Vice Presidents, Weston Gavett, 30 Church Street, New York and R. W. Lindsay, Lyndhurst, N. J.; Treasurer, Edward P. Molitor, Springfield, N. J.; Secretary, John R. Downes, Bound Brook, N. J.

Annual Conference of State and Territorial Health Officers

The Annual Conference of State and Territorial Health Officers with the United States Public Health Service will be held in Washington, D. C., on June 3 and 4.

National Conference on City Planning

The Twenty-first Annual Meeting of the National Conference on City Planning will be held in Buffalo and Niagara Falls, New York, from May 20 to 23, inclusive.

Two of the most significant examples of modern community development—the Country Club District of Kansas City, and Radburn, New Jersey, the new town for the motor age—will be the subjects of papers by the two men who are closest to these developments. J. C. Nichols is the president and founder of the 3,000 acre Country Club District of Kansas City, and Louis Brownlow, formerly chairman of the District Commissioners of Washington, D. C., is municipal consultant of the City Housing Corporation which is building Radburn.

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will be the subject of a paper by George B. Ford, architect and city planner, of New York City. H. S. Buttenheim, who has been investigating the relation of city planning to modern housing, will speak on "Where City Planning and Housing Meet," and Lawrence Veiller, one of the leaders of the housing movement in the United States and Director of the National Housing Association, will discuss "Light, Modern Standards and Ancient Law."

Robert Whitten and Harland Bartholomew will speak on "The Traffic Analysis and Forecast in Its Relation to Thoroughfare Planning" and "Street Replanning in Downtown Districts of Large Cities." These papers will consider the vital changes in the city street systems and regional highways made necessary by the motor. Round table discussions on street planning will take up such questions as street widths, single or double roadways, parkways and building lines.

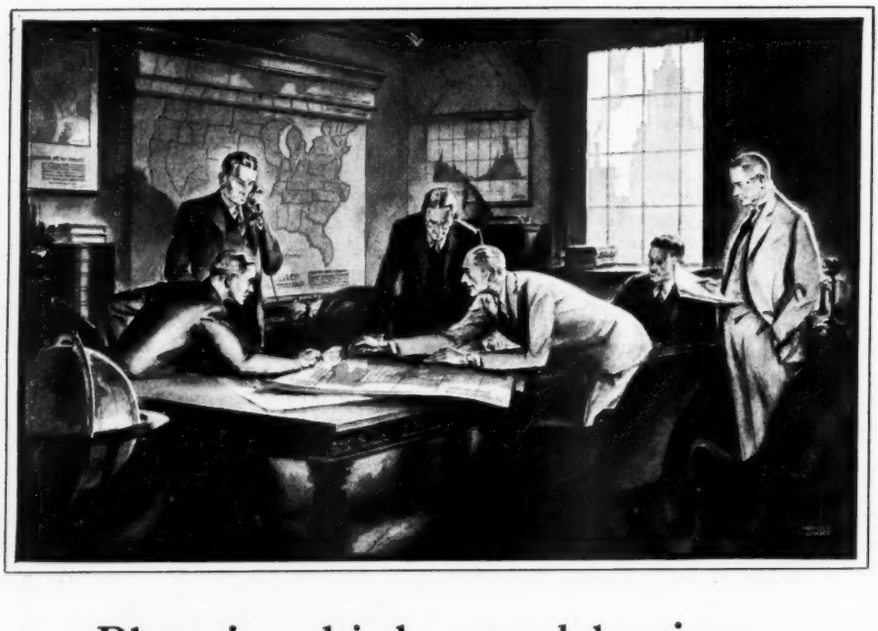
"Trends in Platting Control in the Acquisition of Open Spaces and in the Establishment of Building Lines" will be the subject of a paper by Alfred Bettman, and Professor Ernst Freund will present "Some Inadequately Discussed Legal Aspects of Zoning and City Planning."

The general subject of regional planning will be handled by Thomas Adams, Director of the Regional Plan of New York and Its Environs. Mr. Adams' topic, "The Goals and Snags in Regional Planning," has a special interest from the fact that the New York Regional Plan, after seven years of work, will be completed by the time of the Conference meeting.

Canada's point of view on large area planning will be presented by Horace L. Seymour, Director of Town Planning for the Province of Alberta, where town planning is a governmental function.

The signal achievements in regional planning of Los Angeles County will be the subject of a paper by Charles H. Diggs, Director of the Regional Planning Commission of Los Angeles. The discussion will be led by George C. Diehl, County Engineer of Erie County, New York.

Edward M. Bassett, the President of the Conference, and a leading authority on zoning in the United States, will, in his presidential address, speak on the "Enlarged Usefulness of City Planning Commissions in New York State." Mr. Bassett was the framer of the recent state legislation which made official planning commissions important elements in municipal administration.



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World Engineering Congress

The World Engineering Congress will be held in Tokyo, Japan, from October 29, to November 22, 1929. Many American engineers have signified their intention of attending the Congress and making the tour with the official party.

Many such congresses have been held in the past in Europe and in the United States, but this is the first occasion on which such a gathering has been convened in the Far East. Every effort is being put forward by the Imperial Japanese government, and by the Japanese Engineering Societies, to afford a notable welcome to the visitors in attendance. Every member of the Congress will be a guest of the Japanese Government.

Simultaneously with the World Engineering Congress, a sectional meeting of the World Power Conference will be held in Tokyo.

The authors of papers from the United States include Professor C. A. Adams of Harvard University, Harrison P. Eddy of Boston, John Hays Hammond, Professor D. C. Jackson of Massachusetts Institute of Technology, A. D. Little of Cambridge, F. W. Peek of Pittsfield, Mass., Elmer A. Sperry, John F. Stevens, W. R. Whitney and many others.

A most attractive feature of the Congress is that numbers of excursions and trips have been planned, to

show engineering and industrial developments in Japan as well as the features of interest to tourists in general.

Applications to take part in this tour should be made at an early date. Further information can be obtained from E. Hartford, Secretary of the Committee on Attendance, 29 West 39th Street, New York City.

Massachusetts Highway Association

The fifth annual free exhibition of contractors' and road machinery, held under the auspices of the Massachusetts Highway Association, is to be held on the commonwealth property at Cottage Farm bridge and Memorial Drive, Cambridge, May 7, 8 and 9. Last year nearly 20,000 city and town officials and others interested in contractors' and road machinery attended. This year the demand for space has been so great that fifteen additional plots have been provided, and there is every indication that this year's show will exceed all its predecessors both in point of interest and in attendance. Every new type of road building and contractor's equipment will be shown in operation, including tractors, rollers, graders, ditchers, snow removal machinery, etc.

In addition to Chairman P. G. Holmes, the executive committee in charge of the show includes: David H. Livingstone, superintendent of streets, Dedham, President; John M. McCarthy, Natick, Secretary; Fred W. Matthies, Duxbury; Charles F. Reuter, Winthrop; L. H. D. Anderson, Wellesley; John A. Gaffey, Medford; Franklin C. Pillsbury, project engineer for the Massachusetts department of public works; and Arthur E. Blackmer, Plymouth.

Personals

E. M. Fleming has been appointed Manager of the Highways and Municipal Bureau of the Portland Cement Association with headquarters at the general office in Chicago, effective March 15, succeeding L. S. Trainor who resigned to become associated with McEverlast, Inc., Los Angeles, Calif.

George H. Flinn, president and director of the George H. Flinn Corporation, Booth & Flinn Co., and member of many other companies, died in Pittsburgh, March 29. Mr. Flinn was a noted construction engineer, and his firm has engaged in many large engineering projects.

Ernest P. Goodrich, consulting engineer, 175 Fifth Avenue, New York City has arranged an association with William B. Powell, consulting traffic engineer of Buffalo, N. Y., chairman of the American Engineering Standards Committees on signs, signals and markings. Mr. Goodrich and Mr. Powell will undertake street traffic and related duties for cities and other governmental units, will make recommendations as to traffic signal installations.

Civil Service

Inspector of Airways Construction—Applications for inspector of airways construction must be on file with the Civil Service Commission at Washington, D. C., not later than May 14. The examination is to fill vacancies in the Lighthouse Service, Department of Commerce, and in positions requiring similar qualifications. The entrance salaries range from $2,300 to $2,800 a year. Higher salaried positions are filled through promotion.

The duties consist of the inspection of the work of contractors engaged in the installation of lighting facilities along the civil airways of the United States. The work comprises the installation of wiring, fittings, etc., and the installation and putting into commission of various styles of electric and acetylene beacon lights, as well as gas engine driven generators; the inspection of structural steel, concrete, and wooden structures. The duties may also involve negotiation in connection with the leasing of beacon sites and power contracts and the advertising for and obtaining of materials and supplies under usual Government regulations. The work is largely in the field, and the duties will involve travel and the driving of a car furnished by the Government. Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience, and fitness.

Scientific Aid—Applications will be received by the United States Civil Service Commission until May 7, for

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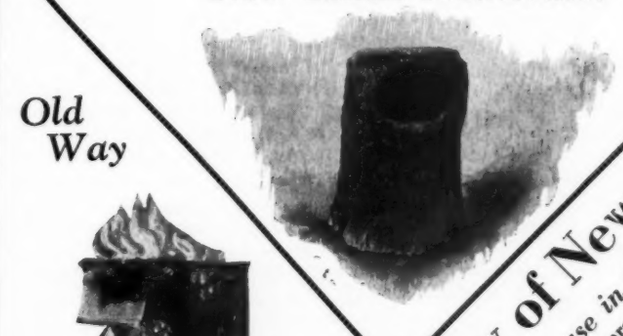

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Assistant Scientific Aide, $1,620 a year and Junior Scientific Aide, $1,440 a year. The examinations are to fill vacancies in the Departmental Service, Washington, D. C., including the Bureau of Standards, and in positions requiring similar qualifications. Optional subjects for the position of assistant scientific aide are general physics, ceramics, chemical engineering, chemistry, civil and mechanical engineering, electrical engineering, paper technology, physical metallurgy, physics and chemistry, and textile technology. For the positions of junior scientific aide and under laboratory apprentice lists of eligibles will be established of those qualified in physics, those qualified in chemistry, and those qualified in both physics and chemistry.

Junior Engineer. — Applications for junior engineer must be on file with the Civil Service Commission at Washington, D. C., not later than May 21. The examination is to fill vacancies in various branches of the service throughout the United States. The entrance salary for positions in Washington, D. C., is $2,000 a year. For appointment outside of Washington, D. C., the salary will be approximately the same. Higher-salaried positions are filled through promotion. The optional subjects are (1) aeronautical engineering, (2) agricultural engineering, (3) chemical engineering, (4) civil engineering, (5) electrical engineering, (6) mechanical engineering, (7) mining engineering, (8) naval architecture and marine engineering, and (9) structural steel and concrete engineering. The duties are to perform routine testing, inspection of engineering material, drawing up plans for minor projects, preparing specifications for engineering material or apparatus, performing field work, making computations, preparing maps, assisting on conduct of experimental research tests, compiling reports, and handling technical correspondence. Competitors will be rated on general physics, mathematics, general engineering, and the optional subject chosen from those named above. Senior students will be admitted to the examination.

Mechancial and Chemical Engineers. —The United States Civil Service Commission announces the following open competitive examinations: Senior Mechanical Engineer, $4,600 to $5,200; Mechanical Engineer, $3,800 to $4,400; Associate Mechanical Engineer, $3,200 to $3,700; Assistant Mechanical Engineer, $2,600 to $3,100; Chemical Engineer, $3,200 to $3,700; Assistant Chemical Engineer, $2,600 to $3,100.

Applications for these positions must be on file with the Secretary of the Fourth U. S. Civil Service District, Washington, D. C., not later than May 14. The examinations are to fill vacancies in the Chemical Warfare Service, Edgewood Arsenal, Md. Competitors will not be required to report for examination at any place, but will be rated on their education, training, experience, and fitness.

Full information may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the United States Civil Service Board of Examiners at the post office or customhouse in any city.

Book Reviews

The Proceedings of the Eighth Annual Meeting of the Highway Research Board. Authoritative papers dealing with needed research, application of research results and reports of important experimental work are the features. Also addresses by Dr. A. F. Woods, Director of Scientific Work, U. S. Department of Agriculture and Dr. E. A. Sperry, Chairman of the Division of Engineering, National Research Council. Topics covered include:

Highway Problems: Mixing of Concrete; Highway Finance; Personal Factor in Highway Accidents; Pavement Maintenance; Traffic Surveys; Intermediate and Low Type Roads; Highway Transportation Costs; Condition of Vehicles.

Application of Research Results: Bearing of Traffic Surveys on Financing of Roads; Rigid Pavement Design including Dowel Spacing, Cross Section, Control of Cracking, Joints, Reinforcement; Smooth Riding Bituminous Pavements; Excess Fine Aggregate in Concrete Pavements; Construction and Maintenance of Bituminous Pavements; Materials for Bituminous Surface Treatments; Summary of Maintenance Developments; Road Capacity.

Research Reports: Maryland Aerial Traffic Survey; Pennsylvania Guard Rail Tests; Mixing of Concrete; Tire Testing; Air Resistance of Automobiles; Wheel Loads and Impact: Distribution of Loads Through Tires; Fill Settlement in Peat Marshes.

The above topics include contributions by Dr. A. N. Talbot, C. N. Conner, T. H. Cutler, J. T. Donaghey, Dr. J. G. McKay, Prof. A. N. Johnson, Sidney J. Williams, Prof. H. B. Shaw, Prof. James Fontaine, Prof. E. H. Lockwood, G. H. Henderson, Prof. E. B. Smith, Samuel Eckels, V. R. Burton, A. C. Benkelman, L. S. Trainor, H. S. Mattimore, Prof. W. J. Emmons, H. J. Kirk, Prof. T. R. Agg, G. E. Hamlin, A. T. Goldbeck, Dr. H. M. Westergaard, L. W. Teller, C. A. Hogentogler, G. C. Dillman and W. A. Van Duzer.

Economics of Highway Bridge Types.—By C. B. McCullough, Bridge Engineer, Oregon State Highway Commission. 246 pages, illustrated. Gillette Pub. Co., Chicago, Ill. $5.

This text has been compiled with a view to its utility not only to the practicing highway engineer, county engineer, city and consulting engineer, but to the undergraduate student in highway and civil engineering as well. The discussion has been prepared for the highway engineer in general rather than the highway bridge engineer.

Cost and quantity curves and data sheets have been made sufficiently general in application to cover average practice and govern estimates of cost of structures designed according to general practice. The tables and curves should prove of benefit to the engineer in the field.

To the student in engineering this work should serve a two fold purpose. First, as an outline of bridge economics and type selection in general it serves to direct his attention, to a most important phase of bridge engineering. Second, the many cost tables, curves and illustrations, covering practically all of the commonly employed types in highway bridge construction, will serve to give a rather comprehensive survey of the ordinary construction types.

Engineering and Construction Equipment

New Machinery, Apparatus, Materials and Methods and Recent Installations.

A New Half-Yard Non-Tilting Mixer by Smith

The T. L. Smith Company, independent division of the National Equipment Corporation, are introducing a new 14-S non-tilting mixer, which is claimed to be unusually simple in construction and fast in operation.

The drum is bigger in diameter and narrow, with 10 deeper full-width discharge buckets and bigger drum openings. It is claimed that these drum improvements permit the use of a wider-throated skip and wider discharge chute, time saving features that assure quicker loading and faster discharge.

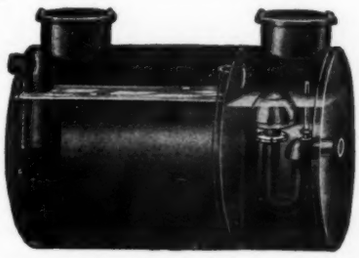
Complete front end operation is provided, with both charge and discharge sides of the mixer visible. The drum rollers are equipped with oversize Timken Bearings in dust tight housings.

Other features include: pressed steel drum heads, short swinging discharge spout and auxiliary stationary spout, band friction hoist clutch and brake, low hot-riveted frame, forged steel rear axle brackets, and wheels that turn under the frame for easy handling. Optional equipment includes a newly designed batch hopper with large swinging gate.

A New Little Buckeye Backfiller

Among the recent developments in construction equipment is the model F backfiller, built by The Buckeye Traction Ditcher Co., Findlay, Ohio, which is a miniature of the bigger Buckeye backfillers, Models D and O.

This small, compact and economical backfiller has a surprising capacity and is capable of easy operation. It is powered with a 4-cylinder, medium speed, heavy duty motor of standard manufacture and Twin disc clutch. The boom has a swinging range of 160 degrees. Brakes of ample dimensions, attached directly to its twin full length Alligator (crawler) traction wheels, provide for safe operation on steep grades and as each wheel is independently driven, the unit can turn completely around in its own length. The operating levers have been conveniently arranged for efficient one-man control and it possesses an extremely practical and sturdy construction throughout its entire assembly. Another feature worthy of mention is that its telescopically adjusted boom is controlled by hand wheels through worm-and-gear mechanisms from the operator's platform, for both elevation and working angles.



SAN-EQUIP SIPHON SEPTIC TANK

Truscon Steel Windows for Industrial Buildings

The Truscon Steel Co., Youngstown, Ohio, has brought out a new, light weight double hung steel window for use in light industrial and other buildings. The new window incorporates spring bronze weather-stripping on all sides and at the meeting rails, insuring positive weathertightness and a minimum of air filtration. It combines large glass area with light weight and the slender, graceful lines which characterize all steel windows.

San-Equip Septic Tanks With Built In Siphon

The Chemical Toilet Corp., Syracuse, N. Y., has brought out the San-Equip Siphon Septic tank. This is their regular septic tank equipped with a siphon, which discharges at four to eight hour intervals in such volume as to send the effluent throughout the filter bed. Every foot of the tile field receives its share of the drainage load. Between the periods of discharge, the drainage field better absorbs the liquid. The periods of rest improve the bacterial process of purification. Possibility of overloading or clogging is reduced. A safer sewage treatment and disposal service is assured at all times.

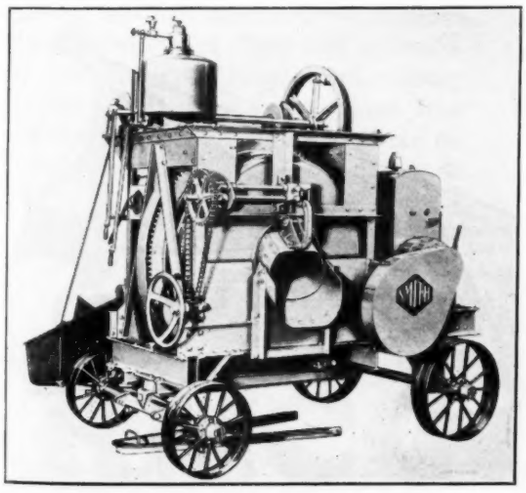
This system, with the new siphon drainage feature, represents the latest improvement in septic tank design and construction. It provides for the intermittent discharge of the effluent to the filter bed or seepage area, allowing intervals of rest which improve the condition of the absorption field and reduce the possibility of overloading or clogging.

This improved system incorporates the septic process and the siphon discharge in one unit which is easily handled and installed, requiring no assembling of parts and the making of no extra connections.

These siphon tank units are made in a large variety of sizes from 240 gallons, suitable for seven to ten persons, up to 3,750 gallons, which will serve 250 persons. The siphon chamber capacity varies from 65 gallons in the smaller tanks up to 700 gallons.

New Floodlighting Projectors

The General Electric Co., Schenectady, has announced a new line of floodlighting projectors which will be of interest to civil engineers and contractors. The new line of projectors



14-S SMITH NON-TILTING MIXER

MODEL F BUCKEYE BACKFILLER

is designed for use in the floodlighting of office buildings, hotels, banks, stores, theaters, factories, power stations, monuments and public buildings, railroad yards, docks, bridges, aqueducts and reservoirs, mines, ornamental fountains, bathing beaches and swimming pools, billboards and outdoor signs, athletic fields and stadiums, filling stations, parking areas and tourists' camps, real estate developments, advertising purposes, night construction work, and similar uses.

The projectors have non-ferrous, and hence non-rusting, casings; and the glass reflectors and lamps are totally enclosed so that dust and dirt cannot enter or impair efficiencies. Ease and accuracy in focusing are attained through the use of unique universal

G. E. PROJECTOR

focusing mechanisms. A small three-point base design and swivel give simple and economical mounting, with ease of installation and orientation of the floodlight beam.

Two sizes of lenses are available, the clear lenses with plain, lightly stippled, heavily stippled and spreadlight distribution. The colored lenses are supplied with plain or heavily stippled distribution. All lenses are of heat-resisting glass. For projectors equipped with clear lenses, color plates of red, amber, blue or green are available. Where projectors are mounted close to the base of the surface to be illuminated, most efficient illumination is afforded by the combination of a new asymmetric reflector and spreadlight lens. The reflectors are of silver-plated glass, protected by copper-backing. Reflectors of the same size are interchangeable in any of the projectors.

The Type L-29 projector, designed primarily for use with a 250-watt floodlighting lamp, is small in size and is particularly adapted for mounting in places where the available space is limited. It is equipped with a medium-angle parabolic reflector, and is suitable for working distances of from 85 to 200 feet. The paraboloidal reflector is 10-7/16 inches in diameter and gives a medium-angle beam of approximately 12 degrees; the asymmetrical reflector produces a wide-angle beam. The lens diameter is 11-1/4 inches. A universally-adjustable swiveled crow-foot base of cast bronze is employed.

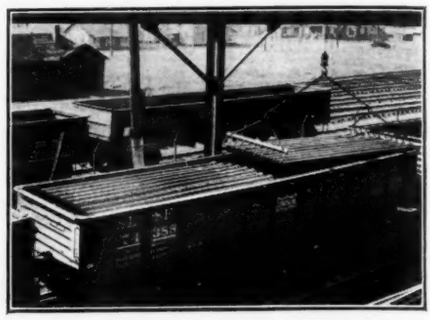
The Type L-30 projector is designed primarily for use with a 500-watt floodlighting lamp. For it there are three reflectors, one giving a medium-angle beam for a working distance up to 400 feet, one of sectional glass construction giving a wide beam for a working distance up to 100 feet, and one of special construction that gives an asymmetric distribution when used with a spreadlight lens. These three reflectors, with the various lenses available, afford any desired distribution of light.

The Type L-31 projector is designed primarily for use with a 1000-watt lamp. One reflector is of composite type, but of a single piece, for general service with 1000-, 750-, 500- or 300-watt PS lamps. It gives a wide beam and is suitable for mounting distances up to 175 feet. Another type of reflector is designed for use with a 1000- or 500-watt G-40 floodlighting lamp. It gives a medium-angle beam and is suitable for working distances up to 400 feet. There is also available a combination of asymmetric reflector and spreadlight lens for use with both the 1000-watt general service lamp and the 1000-watt floodlighting lamp. Types L-30 and L-31 are supported on a swiveled trunnion bracket of bronze, with a bronze crow-foot base that permits universal adjustment of the beam. Their lenses are 15-3/4 inches in diameter.

Cast Iron Pipe in 18-Foot Lengths

The United States Cast Iron Pipe Co., Burlington, N. J., announces that it is now manufacturing 18-foot lengths of deLavaud Centrifugal Cast Iron Pipe in all diameters 4 inches to 12 inches inclusive. A battery of casting machines for the production of deLavaud Pipe in 18-foot lengths is now in operation at the Birmingham, Ala., plant.

With 18-foot pipe, as compared with 12-foot lengths of pipe, there is a reduction of 33 1/3 per cent in the quantity of jointing materials required, in the labor of making the joints themselves and digging the bell holes. There



18-FT. LENGTHS OF CAST IRON PIPE

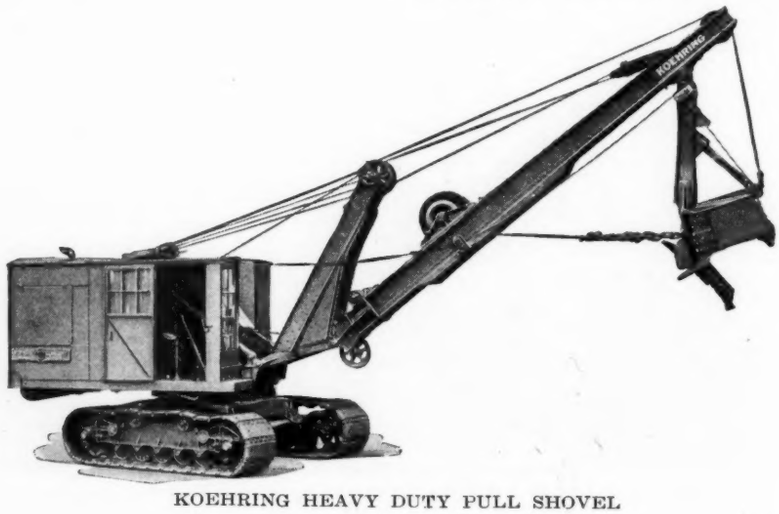
are fewer number of joints which reduce the number of possible points of leakage in the finished line.

The equipment for handling the 18-foot lengths of pipe need be no different from that used in handling 12-foot lengths. On account of the lighter weight per foot, the same number of men can be used to install 18-foot lengths of deLavaud Centrifugal Pipe as are now used for the installation of 12-foot lengths of ordinary pipe.

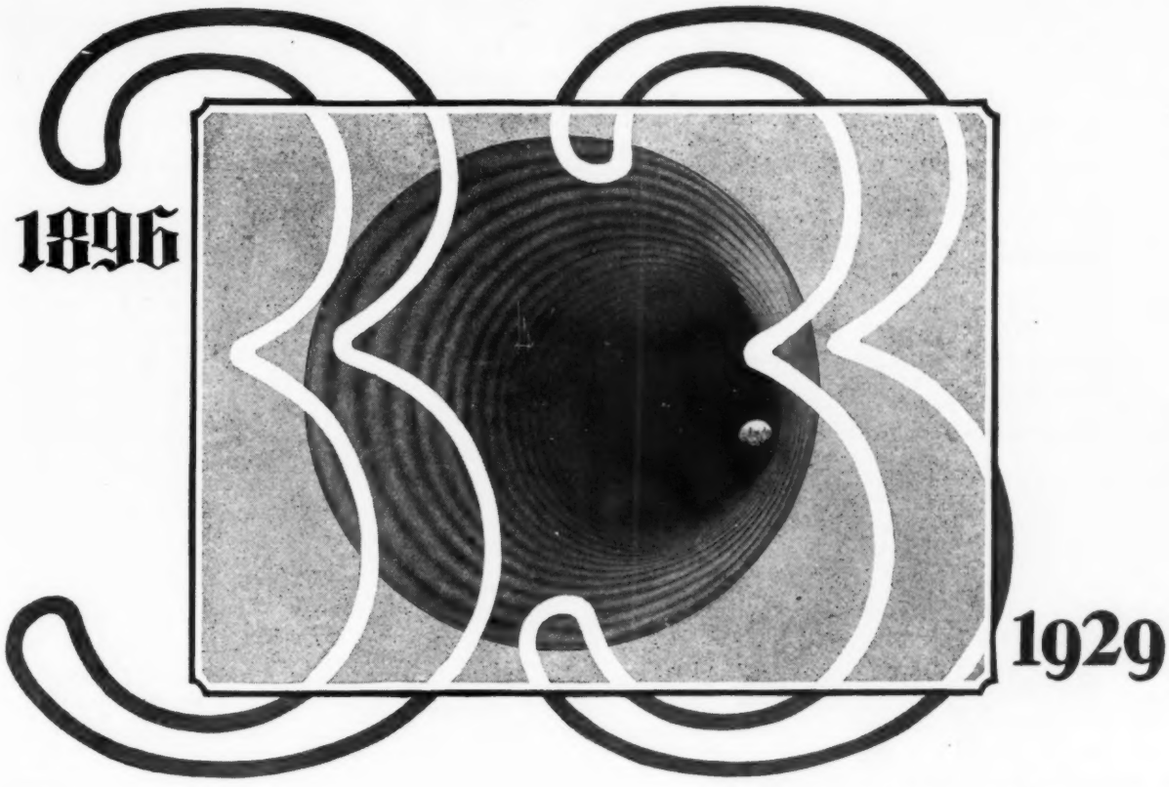
New Koehring Heavy Duty Pull Shovel

The Koehring Company, Milwaukee, Wisconsin, has added the Koehring heavy duty pull shovel to its line of excavating equipment. The outstanding features of this shovel are (1) the shock absorbing principle in the boom base and in the dipper stick and (2) a specially designed jib frame providing a greatly increased working range and flexibility of operation.

The boom shock absorber is identical with that used on the Koehring shovel and in the same manner takes the twisting strains out of the boom and cushions the dipper when trimming the sides of a sewer trench. The dipper stick unit adds power to the digging effort by producing a gnawing action



KOEHRING HEAVY DUTY PULL SHOVEL



33 years prove flexibility

twenty-three years prove pure iron

Armco Corrugated Pipe endures in drainage service

IN 1896 the first corrugated drains were put in service. Flexibility gave these black iron pipes their strength, pure iron gave them their durability. Today, after 33 years use, 85 per cent of them are still in service.

In 1906 Armco Ingot Iron (the purest iron made) was first produced—to improve the uniformity of these first veterans. Today, 23 years of actual service testify to the durability of Armco Ingot Iron in drainage service. There has been no change in the analysis—no change in design since the first Armco Corrugated Iron Pipe was produced in 1906—*that* is significant to the buyer who wishes preproved durability in drainage structures.

"Look under your roads"

The durability in drainage service of Armco Ingot Iron is clearly written under America's roads. You can read this message in every state and province. Armco engineers will gladly assist you in making an actual investigation in your territory.

Armco culverts and drains are manufactured from the Armco Ingot Iron of The American Rolling Mill Company and always bear its brand

ARMCO CULVERT MANUFACTURERS ASSOCIATION
MIDDLETOWN, OHIO

Member of the National Municipal League

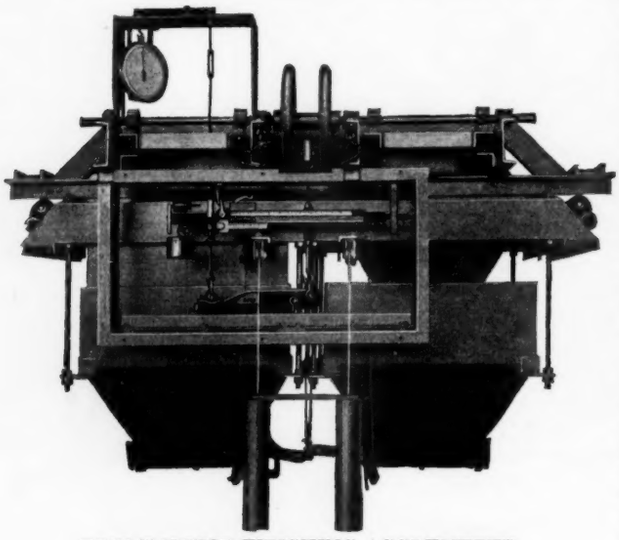
ARMCO *corrugated* **PIPE**

© 1929, A. C. M. A.

"Look under your roads"

in hard, tough digging through the action of the powerful shock absorbing spring upon the dipper.

Instead of being hinged to the turntable casting, as is ordinarily done, the boom is hinged to a separate casting which forms the base of the jib frame. The hinge point on all machines is 60 inches beyond the end of the multiplanes. This provides clearance for lowering the boom and dipper so as to dig its full depth close up to the machine, with the ends of the multiplanes resting on solid ground.



ERIE VOLUME-WEIGHING AGGREMETER

This hinge point can be raised to a working position from 21 to 24 inches above the turntable hinge pin sockets, giving an exceptionally high dumping clearance. Or, the hinge point, may be lowered below the level of the turntable sockets to provide a maximum digging depth. This construction of the jib frame gives the Koehring a flexibility and variation of working range in all operations not obtainable by any similar machine.

The Koehring pull shovel is built in two sizes, equipped with ⅞ and 1¼ cu. yd. dippers. Digging depths range from 17 to 24 feet.

New Heavy-Duty International Motor Trucks

A new line of heavy-duty motor trucks with respective ratings of 2½, 3½, and 5 tons has recently been developed by the International Harvester Co., Chicago, Ill. The new trucks are being made in both the chain-drive and double-reduction types with the exception of the 5-ton size which is of chain-drive type only.

Several important new features are incorporated in the design of these new Internationals, some of which are: new and more powerful engines, four-wheel brakes, single dry-plate clutches with vibration dampers, and transmissions with five forward and two reverse speeds.

The engines of the new Internationals consist of five independently maintained sub-assemblies, which greatly simplify servicing and thus help to keep the truck on the job. The entire engine unit of each truck is clean-cut and compact, and all parts are easily accessible, making possible a quick check-over. It has an overhead valve and camshaft arrangement, which is designed so that valve grinding is a simple bench job, and also made so that lubrication is carried to every moving part. Another important feature of the engine is its aluminum pistons, which are of a patented split-skirt type. Six piston rings are used, three of which are compression rings and the other three of which are oil wipers.

Lubrication of the engine is accomplished by means of a gear type oil pump, which forces the oil through a filter, thence into the main oil line where it is distributed to main and connecting-rod bearings by means of drilled holes. It is next conveyed to the cylinder head where it is forced to camshaft and valve-rocker-arm-shaft bearings and finally it drains down over the timing gear chain and sprockets. The oiling system completely supplies all moving parts, assuring longer life and added performance to the engine.

Erie Combination Volume and Weighing Aggremeters

The Erie Steel Construction Co., Erie, Pa., manufacture the new Erie combination volume and weighing aggremeter, which can be attached to almost any type or make of bin. This is shipped complete, and is claimed to be easy of operation, fast and accurate to within one pound. It is claimed that one operator can weigh and dump a batch of sand and stone in 20 to 30 seconds.

All operating members such as hand wheels for operating gates, trip ropes, and scale beam and dial are not only in convenient location, but are directly in front of and in full view of the operator.

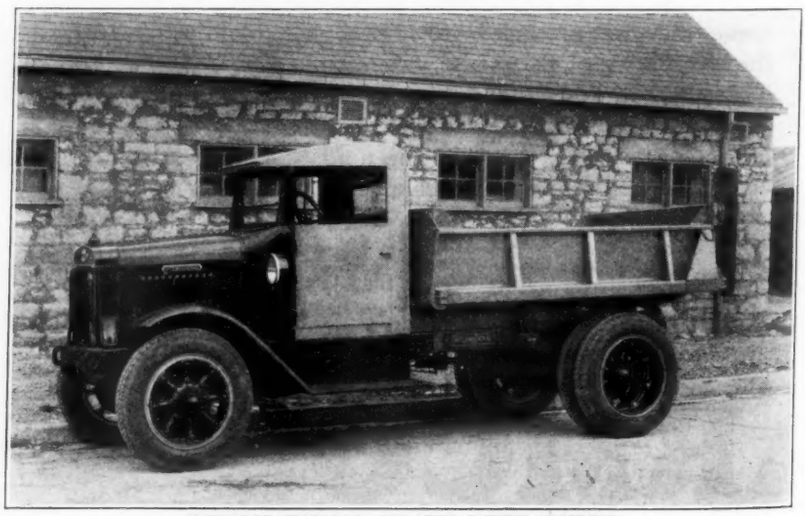
This aggremeter is equipped with full capacity beam scale of 5000 pounds. The large beam is graduated in units of 100 pounds, and the auxiliary beams in units of 1 pound. The auxiliary dial is used only to show the approach to the desired weight.

The rack and pinion gates operate easily and smoothly. When weighing the aggregates the gates are operated separately, and when measuring by volume the gates are operated in unison. The change can be made by removing the pin from the clutch between the hand wheels. The aggremeter can be used for weight or volume one after the other.

Wurtzilite Paints, Coatings and Binders

The American Wurtzilite Company, Builders Building, Wacker Drive, Chicago, has developed a process whereby it is able to convert the bitumen Wurtzilite into a plaster gum and thence into a liquid paint which is being placed on the market. Wurtzilite is a pure hydrocarbon containing oxygen. It is known by most chemists as an oxygenated hydro-carbon or Wurtzilite. When brought into commercial form it is used on iron, steel, leather, rubber, cork, concrete, stucco, tin and glass. After it is applied, the solvents evaporate, leaving an intensely close-grained, luminous, ebony-black veneer which is entirely nonporous. This coating is over 85 per cent pure carbon and is acid, alkali, moisture, oxygen and nitrogen proof. It is also a positive insulating material, thereby preventing the action of electrolysis.

Wurtzilite serves as a coating for tanks and other containers, for solutions

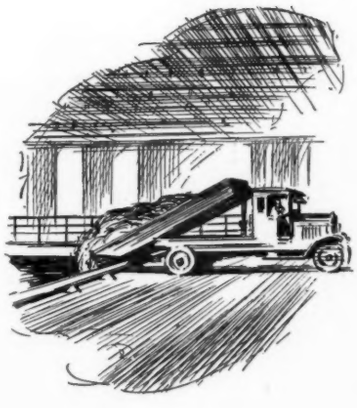


INTERNATIONAL HEAVY DUTY TRUCK

Could you despoil *these who have so little?*

Let us speak candidly of facts: You and I, who live in comfort and in ease, on pleasant streets, in pleasant homes, are far removed in thought and actuality from others of our fellow citizens. We have much. They have little more than basic necessities; shelter, food and air.

They *can't* be despoiled of their enjoyment of any of these—and yet they sometimes are. For when refuse disposal plants are built on city streets, they are *their* streets; and when those plants are unsanitary and pour foul vapors on the air, *they* are the ones to suffer most.



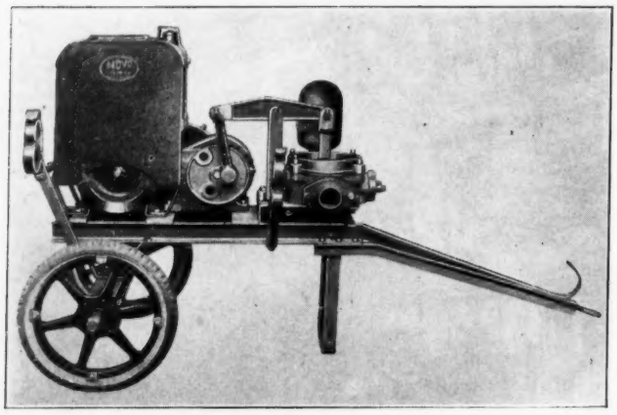
And it is all so unnecessary! Mixed garbage and refuse can be destroyed offenselessly, as the Sterling Destructor destroys it. It can be burned at high temperatures and completely oxidized, as it is in the Mutual-cell furnaces. It can be reduced to sterile gas and clean ash, as it is reduced in Bartlett-Snow installations.

If you would care to know more about our system, write for the Sterling Destructor book.

THE C. O. BARTLETT & SNOW CO.
6221 Harvard Ave. Cleveland, Ohio

Bartlett - Snow

Refuse Disposal Plants



NOVO 21C PUMP FOR PUBLIC UTILITIES

used in galvanizing processes, in tanks used for the recovery of gold and silver from low grade ore, in electro-plating, in pickle factories and other industries wherein unprotected tank surfaces are found to decay through contact with their permanent contents. Experiments extending over a period of years have demonstrated that underground pipes of both wood and iron when coated with Wurtzilite have not been in the least affected by decomposition, the complete prevention of rot and rust having been accomplished. In iron pipes and steel structures which were coated with Wurtzilite electrolysis has been completely frustrated. In its use as a coating for marine craft, either fresh or salt water, Wurtzilite is a permanent agent for protection from the corroding influences of water.

It is claimed that Wurtzilite paint does not depend upon outside oils or any outside pigment for its permanency. The intensly adhesive quality of its own natural pigment hold it firmly and permanently upon the surface. Its continuous unbroken film due to its natural chemical combination excludes all dampness or corroding elements and completely closes every avenue of penetration to the surface of the material upon which the paint is applied. Wurtzilite closes the pores of concrete, making a complete water and weather proofing protective coating and also provides a perfect bond between new and old cement.

New Koehring Concrete Mixer Weighs Water and Aggregate

The Koehring Company of Milwaukee, Wisconsin, manufacturers of pavers, mixers, power shovels and cranes, has recently brought out a new mixer, called the Weigh Mix, in response to a desire by contractors for a portable concrete manufacturing plant that could be charged with available equipment and which would be capable of accurate proportioning of materials by weight.

The Koehring Weigh Mix consists of a standard Koehring mixer, equipped with a weighing batch hopper and water tank mounted on an auxiliary frame carrying pipe lever scales.

All operations are controlled from the operating platform by one man. Materials are weighed into one hopper, thereby allowing for the use of as many aggregates as may be desired; gravel is normally weighed in first, followed by cement and sand; the water is weighed on the same beam and is carried in an open tank.

When the batch hopper door opens to allow for the charging of the mixer, the batchmeter is actuated and the hopper shaking device, operated by a cam on the main driving shaft, is started. The batch hopper discharges quickly, cleaning perfectly so that the scale will return to balance.

By mounting the weighing batch hopper on the mixer, head room is reduced as compared to the use of independent weighing or measuring devices. This allows a compact arrangement of controls for one-man operation. Due to the shape and position of the hopper, bulk cement and any number of differently graded aggregates can be weighed without additional equipment.

The batch hopper does not come in contact with the weighing mechanism while being shaken and therefore the accuracy of the weighing mechanism is not affected. The scale beam is boxed so that it can be taken off the plant for transportation, thereby insuring against damage.

KOEHRING WEIGH-MIX

New Novo Pump for Public Utilities

The Novo Engine Co., Lansing, Mich., has brought out the Novo No. 21 C pump, which is built particularly for the use of public utilities, such as electric and telephone companies, which need pumps for de-watering manholes, tunnels and sewers in emergencies. The 21 C is built with a closed top so that water can be delivered some distance away from the manhole or tunnel. Cleaning out of debris and changing diaphragms can be accomplishd in the quickest possible time. Worn out diaphragms can be taken out and a new diaphragm installed in less than three minutes. Removing one cap screw and loosening another opens the clean-out cover and the dirt, sticks, and debris can then be flushed out easily.

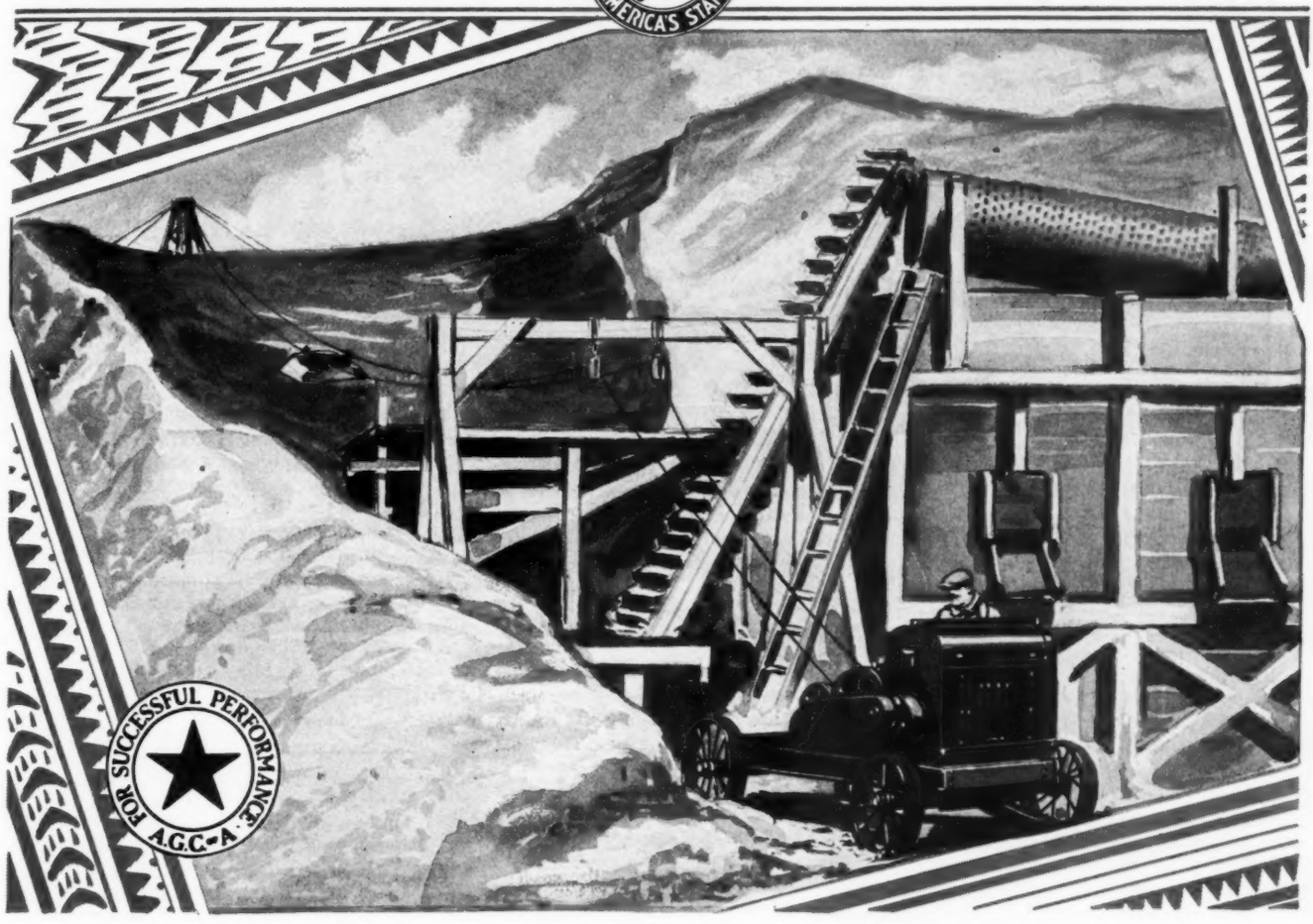
All working parts of the engine and the back gearing are entirely closed and self oiling. These pumps are usually mounted on rubber tire trailers to facilitate transportation. A special feature of these trailers is the coil springs between the frame and axle which absorb the road shocks, making possible higher speeds over any kind of roads. The capacity ranges from 4000 to 5000 gallons per hour with a suction lift of 20 feet. The total head is 50 feet.

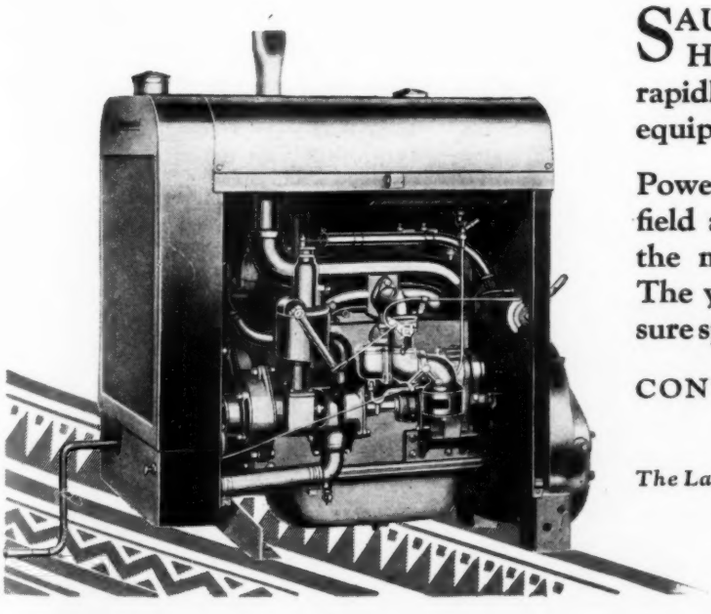
New Truscon Riveted Steel Road Form

A new steel road form to which joint locks and other built-up parts are at-

Dependable Power for Every Purpose

CONTINENTAL MOTORS · Powering the Nation · AMERICA'S STANDARD



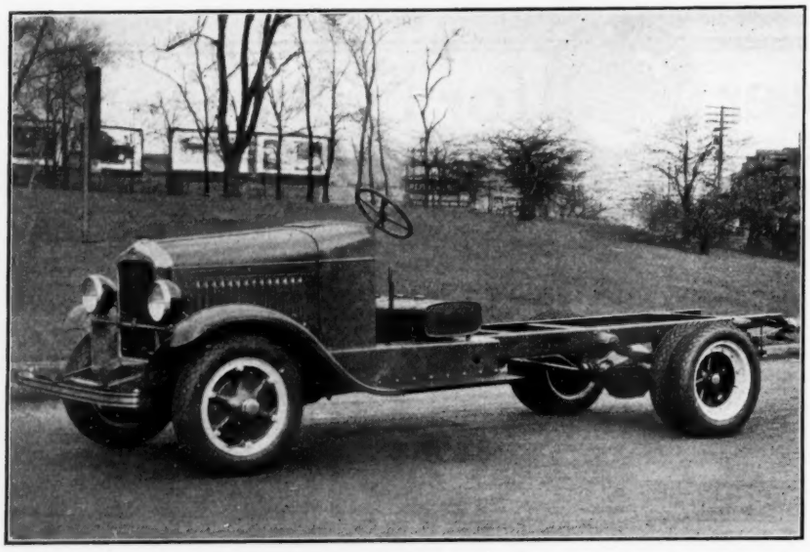


SAUERMAN Portable Scrapers, powered by Heavy Duty Continental Engines are being rapidly chosen by large contractors as standard equipment in excavating work.

Power and ruggedness are necessities in this field and Continental Engines furnish one of the main attributes to successful operations. The years of continuous service which they insure spell greater profits to far-seeing contractors.

CONTINENTAL MOTORS CORPORATION
INDUSTRIAL EQUIPMENT DIVISION
Office and Factory: Muskegon, Michigan
The Largest Exclusive Motor Manufacturer in the World

Continental Engines



WHITE MODEL 61 LIGHT DUTY TRUCK

tached by 3/16-inch hot-driven rivets is being manufactured by the Truscon Steel Company of Youngstown, Ohio. Contractors using forms with rivet attached joint locks and other parts can replace broken or damaged parts on the job without special equipment. Either bolts or rivets may be used in making such repairs. Hot-driven rivets never loosen from use.

The new forms are completely interchangeable; each form is equipped with a male element on the adjacent end of the next form, thus making true alignment of joints always certain. A seven-inch sliding member is driven through keyways on each two adjoining forms and is held by two stakes to form a rigid joint.

The stakes are each 3½ inches from the joint, giving double support where it is most needed. Other stakes may be used wherever necessary between joints. Crooked stakes cannot throw forms out of alignment at joints.

The forms are stamped from 3/16-inch steel by a special machine weighing 100 tons, all bending of the steel being accomplished in one operation on one die. This makes all forms absolutely uniform.

The new form will take bends of 100 feet radius, which is said to be 150 feet shorter radius than is required in standard specifications for the use of steel forms. The short radius is obtained by the short locking apparatus at the joints, a special feature of the Truscon form.

Another outstanding point of the new forms is that they can be combined with any other Truscon form, even the first ones manufactured by that company. Forms of different heights can be joined to give perfect alignment and joints of positive rigidity.

Because of the uniformity of Truscon forms resulting from the method of their manufacture, it is contended that roads built with them will be relatively free from waves and irregularities, moreover, the distinct shape of the top rail of the Truscon form permits the finishing machine to rest on the inside wall of the form rather than on the outside edge of the head, thus saving 2½ per cent or more of the concrete.

White Light Six-Cylinder Truck

The White Co., Cleveland, O., has announced a new six-cylinder light duty truck, having an allowable gross weight rating of 8,000 to 10,500 pounds. The new chassis, known as Model 61, will augment an already wide range of four and six cylinder White models. It will be available in 148 and 170 inch wheelbases. It has a six cylinder engine with large diameter, seven bearing crankshaft delivering smooth, flexible power through a sturdy, four speed transmission.

Easy steering and control combine with four wheel hydraulic brakes to insure complete traffic mastery under all city or inter-city operating conditions. Engine, clutch and transmission are in unit. The crankshaft is dynamically and statically balanced. All valves are on the right side of the "L" head engine, with removable cylinder head and all combustion chambers fully machined. Double Invar strut aluminum alloy pistons are used. Compound jet carburetor and hot-spot manifold give good carburetion at all speeds.

The crankcase breather exhausts around the carburetor intake, allowing the combustible content to be burned with the gas and fumes to be exhausted. This adds to driver comfort and cleanliness of the power plant. The distributor which operates with battery ignition, is mounted on top of the engine block, driven from the oil pump of the pressure system. Thermostatic water control, air and oil cleaning systems, core radiator, attractive instrument board and headlight control on the steering wheel are additional features.

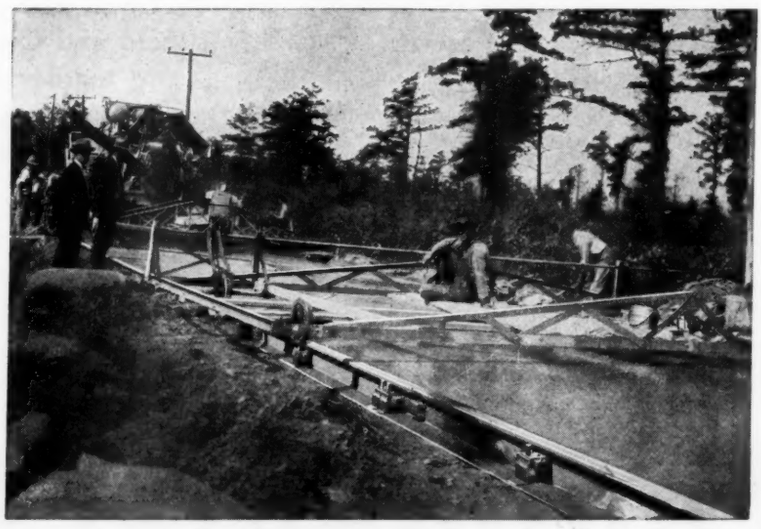
Large frame section with heavy cross members give the chassis adequate capacity for its rating. Dual rear wheels are driven through a sturdy semi-floating rear axle on roller bearings.

Attention has been given to the accessibility of every operating part, a feature of vital importance to the operator because it simplifies servicing. Economy and permanence are further enhanced by adjustment provisions at every possible point, from steering assembly to spring shackles.

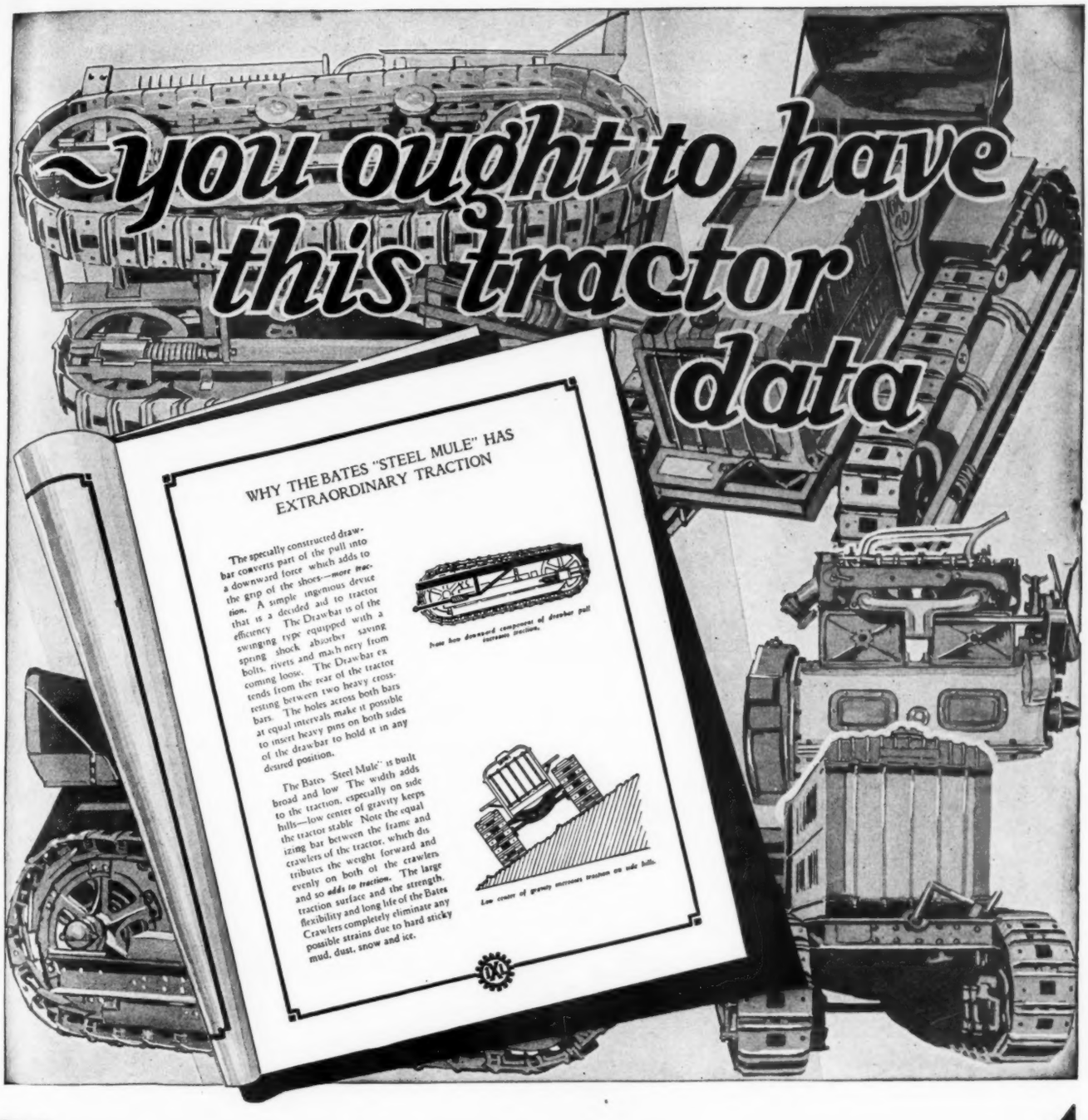
Industrial Notes

The American Hoist & Derrick Company, 63 South Robert Street, St. Paul, announces the appointment of A. R. Gelinas as its agent for Ontario, Quebec and the Maritime Provinces, with an office in the McRitchie & Black Building, 1434 St. Catherine Street, West, Montreal, Quebec, Canada.

The Cleveland Tractor Company, reports the receipt of two orders for large fleets of Cletracs, one from the State Highway Department of Arkansas and the other from the Provincial Government of British Columbia, Canada. The two orders alone amount to more than



TRUSCON RIVETED ROAD FORMS IN USE


you ought to have this tractor data
WHY THE BATES "STEEL MULE" HAS EXTRAORDINARY TRACTION
The specially constructed drawbar converts part of the pull into a downward force which adds to the grip of the shoes—more traction. A simple ingenious device that is a decided aid to tractor efficiency. The Drawbar is of the swinging type equipped with a spring shock absorber saving bolts, rivets and machinery from coming loose. The Drawbar extends from the rear of the tractor resting between two heavy cross-bars. The holes across both bars at equal intervals make it possible to insert heavy pins on both sides of the drawbar to hold it in any desired position.
The Bates "Steel Mule" is built broad and low. The width adds to the traction, especially on side hills—low center of gravity keeps the tractor stable. Note the equalizing bar between the frame and crawlers of the tractor, which distributes the weight forward and evenly on both of the crawlers and so adds to traction. The large traction surface and the strength, flexibility and long life of the Bates Crawlers completely eliminate any possible strains due to hard sticky mud, dust, snow and ice.
Note how downward component of drawbar pull increases traction.
Low center of gravity increases traction on side hills.

On the The Bates Steel Mule

This tractor book contains just the information you need to make a comparison and wise selection when you buy.

Free—just clip and mail the coupon.

Describes the Bates "30," "40" and "80" "Steel Mule" Tractors.

P. W. B-103

FOOTE BROS. GEAR & MACHINE CO.
241-245 N. Curtis St.
CHICAGO, ILL.

Please send me copy of The Bates Tractor Book.

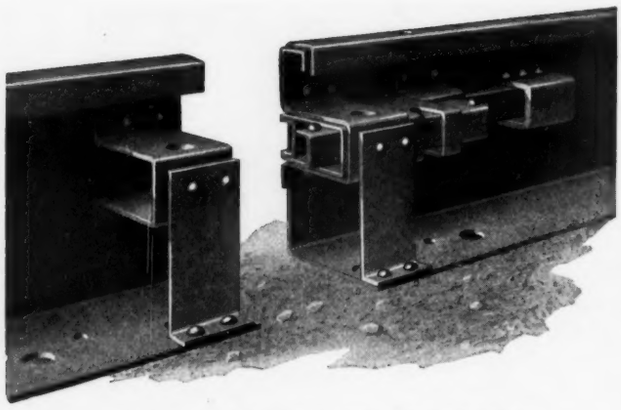
Signed_____

Address_____

FOOTE BROS. GEAR & MACHINE CO.
Road Machinery Division
241-245 No. Curtis St., Chicago

Established 1859

Sales and Engineering Offices in All Principal Cities, U. S. A., and Canada



DETAIL OF TRUSCON RIVETED FORMS

$100,000. These sales constitute repeat business in each case and bring the total number of Cletracs used by the Provincial Government of British Columbia up to eighty-two machines. The tractors will be used by these Departments for road construction and maintenance purposes.

Clarence H. Buell, 404 S. Clinton St., Syracuse, N. Y. is distributor for the Novo Engine Company in the central part of New York state. The entire line of Novo equipment will be handled including pumps, hoists, draglines, engines, lighting units, etc.

Bay City Shovels, Inc. (formerly Bay City Dredge Works), Bay City, Michigan, announce the letting of a contract to H. C. Webber Construction Company for the construction of a new factory building to be used for assembly of Bay City Power Shovels and Cranes. The new building is to be of brick and steel, modern fireproof construction, and will provide an additional 18,000 square feet of floor space, necessary for increased production of Tractor Shovels and the New Model K, full-revolving shovel. The new assembly building is to be equipped with a ten-ton electric traveling crane.

The new plant of the Hooker Electrochemical Co., which has just come into production at Tacoma, Wash., has an initial output of 30 tons of 76 per cent caustic soda and 26 tons of cell chlorine daily. Construction work on this plant was begun last August and the plant completed in the record time of six months.

Caustic soda will be shipped as solid fused, flake, or as liquid; the solid in steel drums made up at the plant and which contain approximately 700 pounds. The flake caustic is placed for shipment in similar drums containing about 400 pounds. Liquid caustic will be shipped in tank cars, by tanks mounted on barges, or in tank steamers. The company plans to distribute a considerable portion of its liquid caustic soda in tank steamers at its Tacoma dock, transferring to a storage station now under construction in Los Angeles harbor, and from this station shipping in 8,000 gallon tank cars to the consumer. Muriatic acid will be shipped in small quantities in glass carboys containing about 115 pounds, and in larger quantities in rubber lined tank cars holding 35 tons or more. In the east the company was one of the first to develop the use of rubber lining for the handling of muriatic acid. Liquid chlorine is shipped in containers varying in size from 100 pounds to 60,000 pounds. The smaller containers which are known as cylinders are of two standard sizes, one containing 100 pounds net and the other containing 150 pounds net.

Thirty-two large independent makers and distributors of tractors, farm implements and industrial equipment in North America have organized as the United Tractor and Equipment Corporation. Combined assets of the companies in the cooperative manufacturing and marketing movement are above $125,000,000.

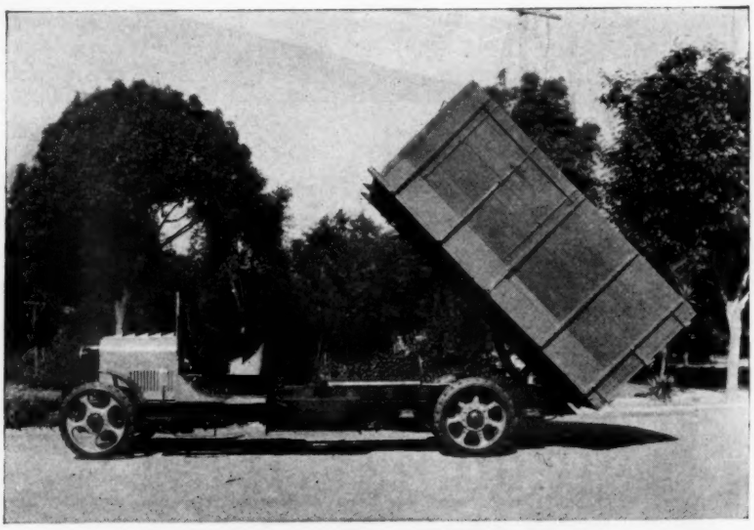
Through several hundred selected dealers in the United States and Canada, the members, fifteen manufacturers and seventeen distributors, will market a full line of farm and industrial tractor equipment designed to be operated with their tractor, the United. The tractor is in full production under contract by the Allis-Chalmers Manufacturing Company of Milwaukee, a member of the corporation. The products of the members to be operated with the tractor will carry the United trademark and color scheme.

Enrolled in the corporation membership are these manufacturers:

Allis-Chalmers Manufacturing Company, tractors, the Wehr Co., road building machinery and rubber-tired industrial wheels, and the Trackson Co., logging hitches, full crawler attachments, cranes, bulldozers and backfillers, all of Milwaukee, Wis.; Brookville Locomotive Co., gasoline locomotives, Brookville, Pa.; Dorsey Brothers, stump pullers and land clearing equipment, Elba, Ala.; Hughes-Keenan Co., "Iron Mule" self-contained dump tractors, and the Roderick Lean Manufacturing Company, field type disc harrows, Mansfield, O.; C. H. Turner Manufacturing Co., saw mill equipment and cordwood saws, Statesville, N. C.; the Perry Co., scrapers, Perry, O.; Muskogee Iron Works, double and single-drum hoists and oil field equipment, Muskogee, Okla.; Brenneis Manufacturing Co., orchard harrows, Los Angeles, Calif.; Ferguson Manufacturing Co., wheelless plows, Evansville, Ind.; Universal Power Shovel Company, power shovels, Detroit, Mich.; Athens Plow Company, trailing and side disc plows, Athens, Tenn.; Moline Implement Company, general line of agricultural implements, Moline, Ill.

The officers of the Corporation are: Milton W. Anderson, president and general manager; W. B. May, of W. B. May, Inc., Buffalo, N. Y., vice president; E. R. Wehr, the Wehr Company, Milwaukee, secretary-treasurer; Walter Stiemke, the Trackson Company, Milwaukee, assistant secretary-treasurer.

A Well-Designed Refuse Collection Outfit



The newest addition to the fleet of the Oakland Scavenger Company of Oakland, California is a 3-ton Fageol. The truck is constructed with an extra low frame permitting a low over all height when body is mounted. The 16-cu. yd. body, built by the Oakland Scavenger Company, is equipped with a Wood F-6 Hoist.

Remove the Pressure
That Ruins Valuable Tracings

EVERY SHEET ON TOP

The new Hamilton-Calumet Plan File System makes it possible for every sheet to be a top sheet. You don't have to "drag" the desired tracing from under the weight of the other sheets in the drawer.

FIG. 1

FIG. 2

FIG. 3

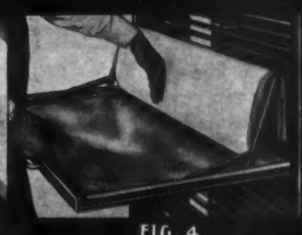


FIG. 4

FIG. 5

The patented Tracing Lifter, removes the pressure that is so injurious to valuable tracings, see fig. 3.

This is only one of the new features of the Hamilton-Calumet Plan File System. Our new catalog No. 8 is now off the press and will be sent to anyone upon request. Use the coupon. There is a HAMILTON dealer near you.

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HAMILTON MFG. CO.
TWO RIVERS, WIS.

Hamilton Mfg. Co., Two Rivers, Wis.
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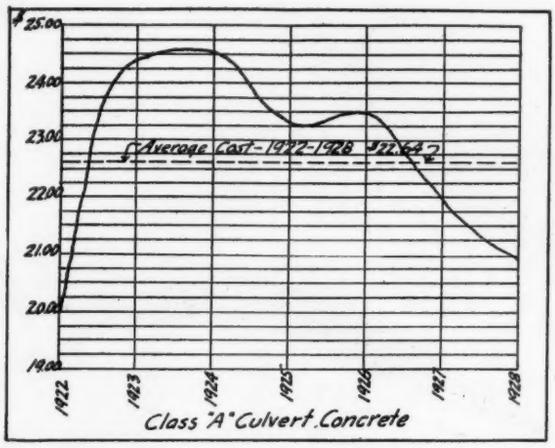
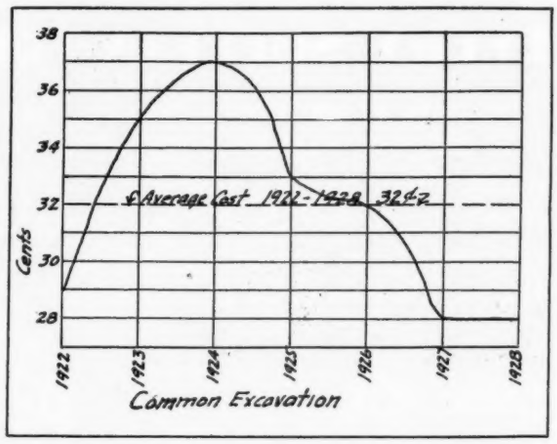
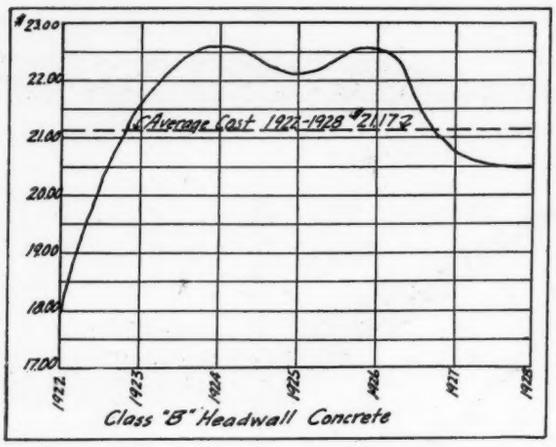
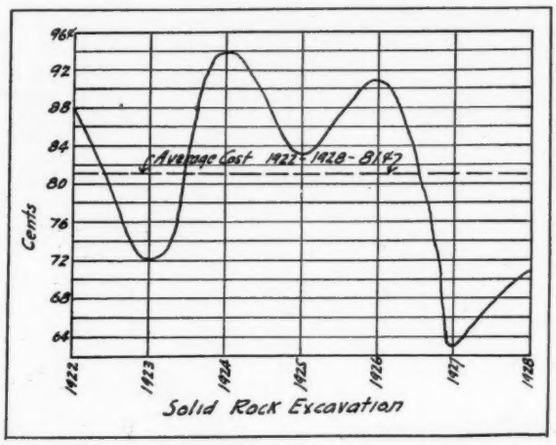
Itemized Costs of Construction

Average Costs of Construction on Alabama State Highways, 1922-1928, as Based on Unit Prices of Successful Bidders.









STATEMENT OF THE OWNERSHIP MANAGEMENT, CIRCULATION, etc., required by the Act of Congress of August 24, 1912, of PUBLIC WORKS, published monthly at New York, N. Y., for April 1, 1929.

State of New York, County of New York, ss.: Before me, a Notary Public in and for the State and county aforesaid, personally appeared James T. Morris, who having been duly sworn according to law, deposes and says that he is the business manager of the PUBLIC WORKS, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are:

Publisher—Public Works Journal Corp., 243 West 39th St., New York, N. Y.
Editor—A. Prescott Folwell, Montclair, N. J.
Managing Editor—A. Prescott Folwell, Montclair, N. J.
Business Manager—J. T. Morris, White Plains, N. Y.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Public Works Journal Corp., 243 West 39th St., New York, N. Y.
Sumner W. Hume, 243 West 39th St., New York, N. Y.
James T. Morris, White Plains, N. Y.
A. Prescott Folwell, Montclair, N. J.
Contracting Publishing Co., New York, N. Y.
Stockholders of Contracting Publishing Co.:
H. F. Pomeroy, 342 Madison Ave., New York, N. Y.
J. R. Breuchaud, 342 Madison Ave., New York, N. Y.
H. F. Hackerdorn, Consumers Bldg., Chicago, Ill.
Frank W. Skinner, 20 Vesey St., New York, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

Swetland Publishing Co., 243 West 39th St., New York, N. Y.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

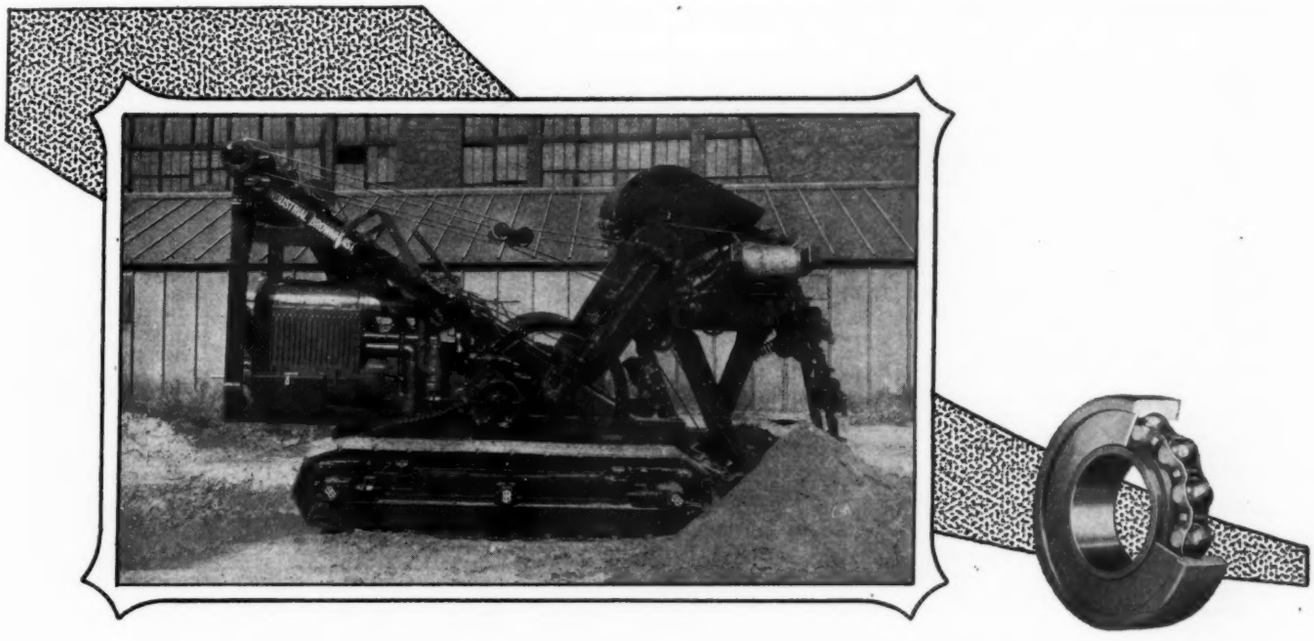
5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is (This information is required from daily publication only.)

J. T. MORRIS, Business Manager.

Sworn to and subscribed before me this 1st day of April, 1929.

(Seal) R. CROXTON MORRIS.
NOTARY PUBLIC, WESTCHESTER COUNTY, N. Y.
Cert. filed in N. Y. Co. No. 335, Reg. No. 1M331.
Commission expires March 30th, 1931.

The Pony-Ditcher Eats Dirt, But Dirt Can't Eat the Bearings



IF you believe that all ditchers are alike it's because you don't know the latest Topping Pony-Ditcher. Built for speed right from the ground up, it eats dirt and is so constructed that it likes it. This better built ditcher will keep going and be on the job digging out dollars for you when an ordinary machine is taking time out for repairs.

For example, dirt doesn't bother the bearings on the Pony-Ditcher because all high speed shafts are mounted on ball bearings and run in oil. Nor does clay clog in the buckets because each is individually self-cleaning. Split sprockets with cut teeth and made of special steel, electrically welded frames for strength without excess weight and a full crawler mounting with modified one-shot lubrication help make this ditcher a buy that you will find hard to duplicate.

Pony-Ditcher capacities range from 13 to 30 inches in width by 7½ feet deep. An interesting booklet has been prepared giving complete information on this machine. Write for a copy.

This shows the dirt-proof ball bearings used in the Pony-Ditcher. These bearings are mounted on all high speed shafts.

Industrial Brownhoist Corporation, General Offices, Cleveland, Ohio

District Offices: New York, Philadelphia, Pittsburgh, Detroit, Chicago, New Orleans, San Francisco.

Plants: Brownhoist Division, Cleveland; Industrial Division, Bay City, Michigan; Elyria Foundry Division, Elyria, Ohio.

INDUSTRIAL BROWNHOIST

Itemized Costs of Construction

Contract 29—Wanaque Aqueduct
Reinforcement of Wanaque Tunnel and Approaches

Fuller & McClintock, Engineers in charge.

North Jersey District Water Supply Commission

Canvass of Bids Opened March 20, 1929, 11:10 A. M.

(1) Lock Joint Pipe Co., Ampere, N. J.; (2) C. F. McEvoy Co., Newark, N. J.; (3) P. F. Connelly, Long Island City; (4) J. P. White & Co., Passaic, N. J.; (5) Maggi & Schoonover, Paterson, N. J.; (6) James F. Murphy Cont. Co., Inc., New York City; (7) Frederick Snare Corp., New York City.

Item—Description	Quantity	Unit of Measure	(1) Unit Price	(2) Unit Price	(3) Unit Price	(4) Unit Price	(5) Unit Price	(6) Unit Price	(7) Unit Price
1 Earth excavation, general	2,000	cu. yds.	$ 2.50	$ 1.50	$ 3.00	$ 1.50	$ 1.50	$ 2.00	$ 1.95
2 Earth excavation in sheeted trench	750	" "	3.25	3.00	5.00	5.00	9.50	4.00	8.15
3 Rock excavation	500	" "	7.50	8.00	7.50	7.00	4.00	9.00	10.40
4 Compacted refill	300	" "	1.00	1.50	1.00	.50	2.00	1.00	1.30
5 Concrete masonry	350	" "	25.00	22.00	30.00	20.00	29.00	20.00	17.35
6 Steel for reinforcing concrete	10,000	pounds	.06	.06	.10	.06	.06	.07	.065
7a 84" reinforced concrete pipe	1,485	lin. ft.	56.50	53.00	65.00	80.00	77.76	95.00	92.00
7b 88" steel pipe	1,485	lin. ft.							
8 Steel pipe and specials	160	tons	250.00	325.00	225.00	250.00	252.00	240.00	230.00
9 Steel castings	7,500	pounds	.18	.25	.30	.25	.20	.30	.30
10 Cast iron pipe specials	15	tons	240.00	200.00	300.00	150.00	250.00	200.00	234.75
11 Miscellaneous metal work	1,500	pounds	.20	.20	.30	.20	.20	.30	.40
12 60" gate valves, with bypass	1	each	4,350.00	4,377.00	4,500.00	5,000.00	4,350.00	4,500.00	4,565.00
13 48" gate valves, without bypass	2	"	2,675.00	2,640.00	2,500.00	2,675.00	2,800.00	2,400.00	3,250.00
14 48" gate valves, with bypass & elec. oper. mech.	2	"	4,300.00	4,500.00	4,500.00	4,300.00	4,450.00	4,500.00	5,150.00
15 36" gate valves	5	"	1,375.00	1,380.00	1,500.00	1,500.00	1,745.00	1,400.00	1,790.00
16 24" gate valve	1	"	500.00	500.00	600.00	600.00	685.00	600.00	715.00
17 12" gate valves	2	"	82.50	152,00	100.00	100.00	140.00	110.00	160.00
18 8" gate valves	2	"	50.00	60.00	100.00	75.00	60.00	50.00	85.00
19 6" gate valve	1	"	50.00	60.00	75.00	60.00	60.00	55.00	85.00
20 3" gate valves	4	"	25.00	27.00	35.00	25.00	25.00	25.00	42.50
21 2" gate valves	2	"	20.00	23.00	13.25	15.00	25.00	20.00	39.00
22 6" vacuum air valve	1	"	160.00	155.00	200.00	160.00	235.00	160.00	202.00
23 3" vacuum air valves	4	"	75.00	115.00	150.00	100.00	150.00	100.00	137.00
24 Pressure air valves	2	"	35.00	39.50	50.00	30.00	50.00	50.00	54.00
25 84" Venturi meter	1	"	7,500.00	12,000.00	8,500.00	9,000.00	9,000.00	12,000.00	10,677.00
26 Timber and lumber	5	M. ft. B. M.	60.00	100.00	100.00	100.00	100.00	50.00	117.00
27 Installing material furnished by Commission		lump sum	500.00	4,000.00	1,000.00	1,000.00	650.00	1,800.00	1,350.00
28 Cleaning up		lump sum	800.00	200.00	1,000.00	100.00	1,000.00	100.00	1,500.00
TOTALS			$185,750.00	$197,969.00	$204,166.50	$220,035.00	$225,773.60	$245,900.00	$248,939.25

Tucson-Nogales Highway, Arizona
Federal Aid Project No. 86-C

Completion Date 11-30-29: Bids Opened March 15, 1929.

(1) Engstrum Constr. Co., Los Angeles, Calif.; (2) General Constr. Co., Phoenix, Ariz.; (3) Canion & Francis, Phoenix, Ariz.; (4) Geo. W. Orr, El Paso, Tex.; (5) John Mulligan, San Carlos, Ariz.; (6) Lee Moor Constr. Co., El Paso, Tex.; (7) Frank Lown, Nogales, Ariz.

Quantity—Unit	(1) Price	(2) Price	(3) Price	(4) Price	(5) Price	(6) Price	(7) Price
42,573 C. Y. Excav. Roadway (Unclass)	.415	.48	.48	.40	.43	.58	.60
36,508 " " Borrow (Unclass)	.33	.32	.26	.40	.35	.35	.30
1,372 " " Structures (Unclass)	1.25	.75	1.05	.80	.80	1.00	1.00
1,833 " " Ditches-Chls & Dykes (Unclass)	.40	.40	.30	.35	.30	.25	.50
8,384 St. Yd Overhaul Earthwork	.03	.025	.04	.04	.03	.03	.025
617 C. Y. Cl. "A" Conc. (C. I. P.)	20.00	22.50	23.50	23.85	25.00	23.50	27.50
98 " Cl. "B" " "	17.00	21.50	22.50	23.85	24.00	23.50	13.00
2 Each Cattle Guards (C. I. P.)	1000.00	300.00	400.00	450.00	300.00	325.00	76.50
214 Lin. Ft. 24" C. M. P. (C. I. P.)	350	2.00	3.00	2.80	2.50	2.57	2.00
86 Lin. Ft. 30" C. M. P. (C. I. P.)	5.00	2.50	4.00	3.30	3.00	3.25	2.00
234 Lin. Ft. 36" C. M. P. (C. I. P.)	5.75	4.00	5.00	4.00	4.00	3.86	3.00
3870 Lin. Ft. Mesh Guard Fence (C. I. P.)	1.20	.70	1.00	.85	.80	.90	1.00
37,410 Lbs. Rein. Steel (C. I. P.	.055	.05	.06	.065	.055	.055	.075
1.5 Mi. Removing & Rebuilding Fence	1000.00	250.00	400.00	132.00	200.00	150.00	132.50
Removing Old Conc. Culverts	60.00	225.00	125.00	50.00	100.00	100.00	200.00
STRUCTURES OVER 20' CLEAR SPAN							
698 C. Y. Excav. (Unclass)	3.50	.75	1.20	.80	.80	1.00	1.35
10 C. Y. Cl. "AA" Conc. (C. I. P.)	120.00	65.00	80.00	60.00	75.00	75.00	55.00
595 C. Y. Cl. "A" Conc. (C. I. P.)	26.00	22.50	23.50	23.85	24.50	24.00	27.50
38 C. Y. Cl. "B" (C. I. P.)	20.00	21.50	22.50	23.85	23.50	24.00	13.00
55,541 Lbs. Rein Steel (C. I. P.)	.57	.05	.06	.065	.055	.055	.075
Each Plate Bridge Seats (C. I. P.)	50.00	20.00	19.00	40.00	18.00	20.00	12.50
	82,646.05	75,752.45	78,712.64	79,633.42	78,620.41	84,457.43	88,199.67
10 per cent Engr. & Contgs.	8.264.60	7,575.24	7,871.26	7,963.34	7,862.04	8,445.74	8,819.96
	90,910.65	83,327.69	86,583.90	87,596.76	86,482.45	92,903.17	97,019.63